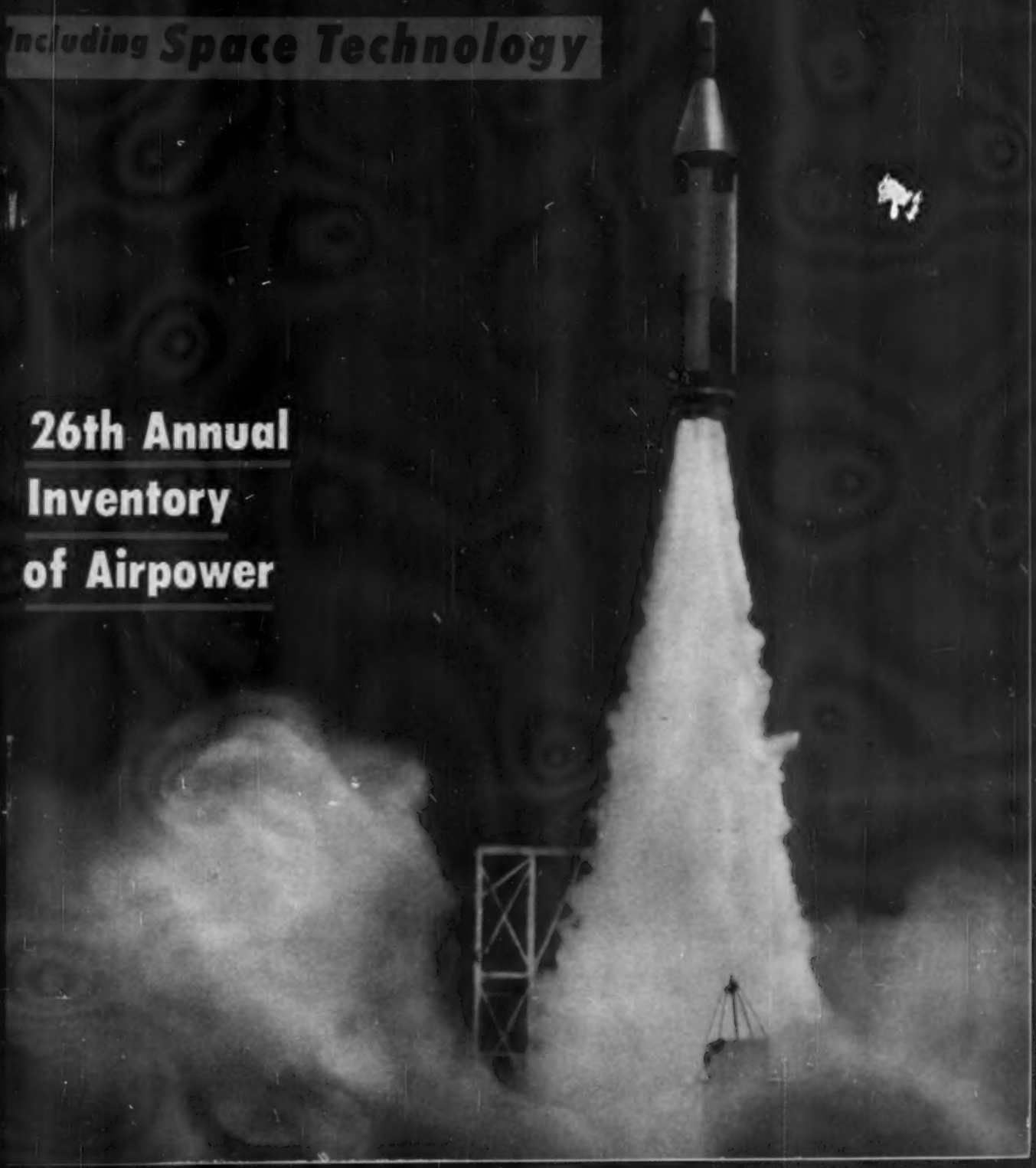
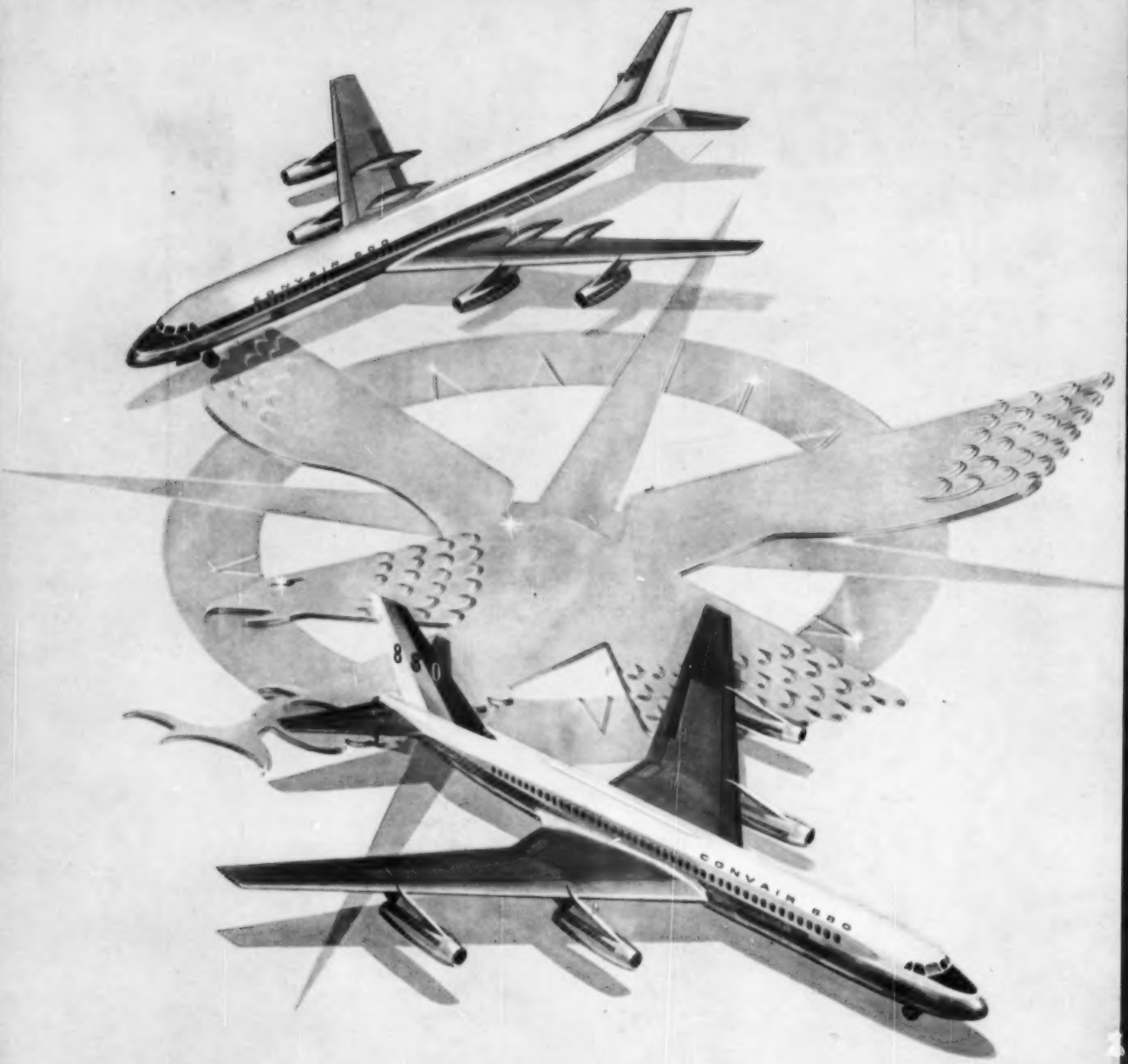
MARCH 9, 1959

Aviation Week

Including Space Technology



26th Annual Inventory of Airpower



Convair 880 and 600 Jet-liners

YEARS AHEAD FOR YEARS TO COME

Years ahead in every detail, Convair Jet-Liners are leaders for the new jet age . . . designed with precision and crafted to perfection! The ultimate in modern engineering concepts! The very finest expression of elegance and comfort! Advanced beyond all other means of transportation, Convair 880 and 600 Jet-Liners, the world's fastest passenger planes, will be *years ahead for years to come!*

CONVAIR
A DIVISION OF **GENERAL DYNAMICS CORPORATION**

First to offer Convair 880 or 600 Jet-Liner service will be TWA, DELTA, TRANSCONTINENTAL (Argentina), REAL-AEROVIAS (Brazil), S.A.S., SWISSAIR, AMERICAN

VICKERS®

Airborne Variable Displacement Piston Type Pumps

A NEW LINE of Vickers Variable Displacement Piston Type Pumps is now available for aircraft applications at *4000 psi pressure.* These new pumps have the same exceptionally high overall efficiency as well as the many other performance advantages demonstrated by the 3000 psi Vickers pump series throughout millions of hours of dependable airborne service. Flow characteristics and maximum recommended speeds are also the same for both series.

An important feature of the 4000 psi series is a CONTAMINANT-TOLERANT DESIGN enabling successful operations in hydraulic fluids and engine lubricating oils with particle sizes up to 40 microns.

Operation of airborne hydraulic systems at 4000 psi is finding increasing favor because it means smaller actuators and less fluid in the system . . . resulting in an overall weight and space advantage.

Vickers 4000 psi hydraulic motors and fixed displacement pumps will also be available. For further information about 4000 psi pumps and motors, please write for Bulletin A-5219 or get in touch with the nearest Aero Hydraulics Division office listed below.

7880

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

We would like to paraphrase the 1959 IRE Show theme, Inspiration in Radio Electronics, by pointing out this example of Kennedy Inspiration in Reflector Engineering, a 40-foot reflector featuring quick in-the-field assembly and disassembly.

You can see this unique antenna at Booths 2532 and 2637 at the IRE Show.

Circle Number 2 on Reader-Service Card

ANTENNA EQUIPMENT

D. S. KENNEDY & CO.

COHASSET, MASS. EVergreen 3-1200

Down-To-Earth SOLUTIONS *to Out-Of-This-World* PROBLEMS

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Radio Telescopes
Radar Antennas
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Tropospheric Scatter
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March 9, 1959
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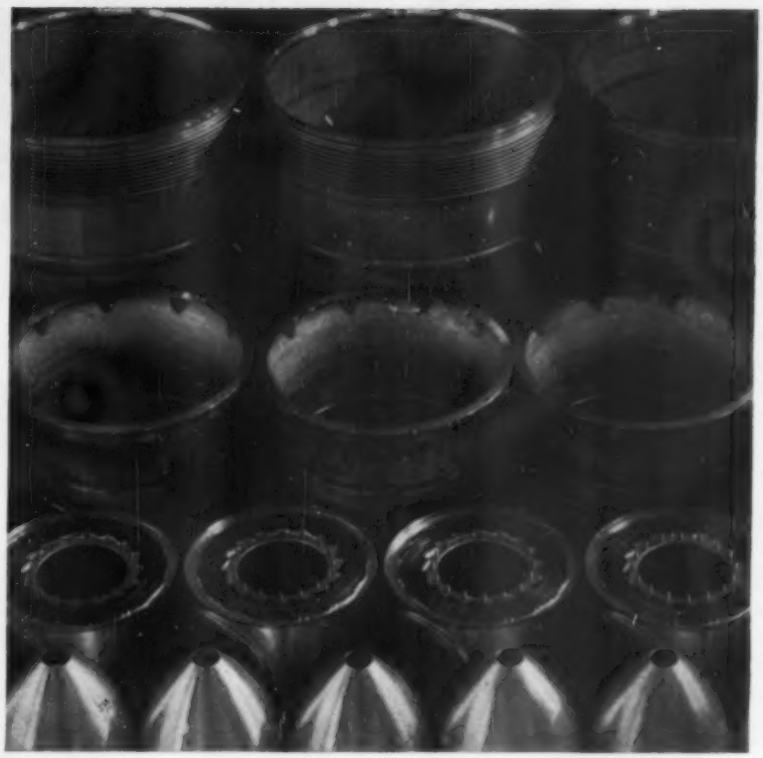

high temperature / AVIATION COMPONENTS BY LAVELLE

Lavelle manufactures aviation components to meet the most critical demands of high temperature operation. Typical of the many high temperature units produced in quantity by experienced Lavelle craftsmen are the jet engine tail pipes, engine casings and heat exchangers shown above.

Lavelle specializes in the production of precision sheet metal weldments and assemblies made of titanium, aluminum, stainless steel, and heat-resistant nickel alloys . . . joined by welding methods applicable to specific component design and function. Where required, special tools are designed and fabricated by Lavelle to maintain production quality, reduce costs . . . and promote on-schedule delivery.

If your requirements for component performance demand the very highest standards of component workmanship, call on Lavelle . . . or write for brochure describing specialized skills and facilities ready to serve your needs.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.
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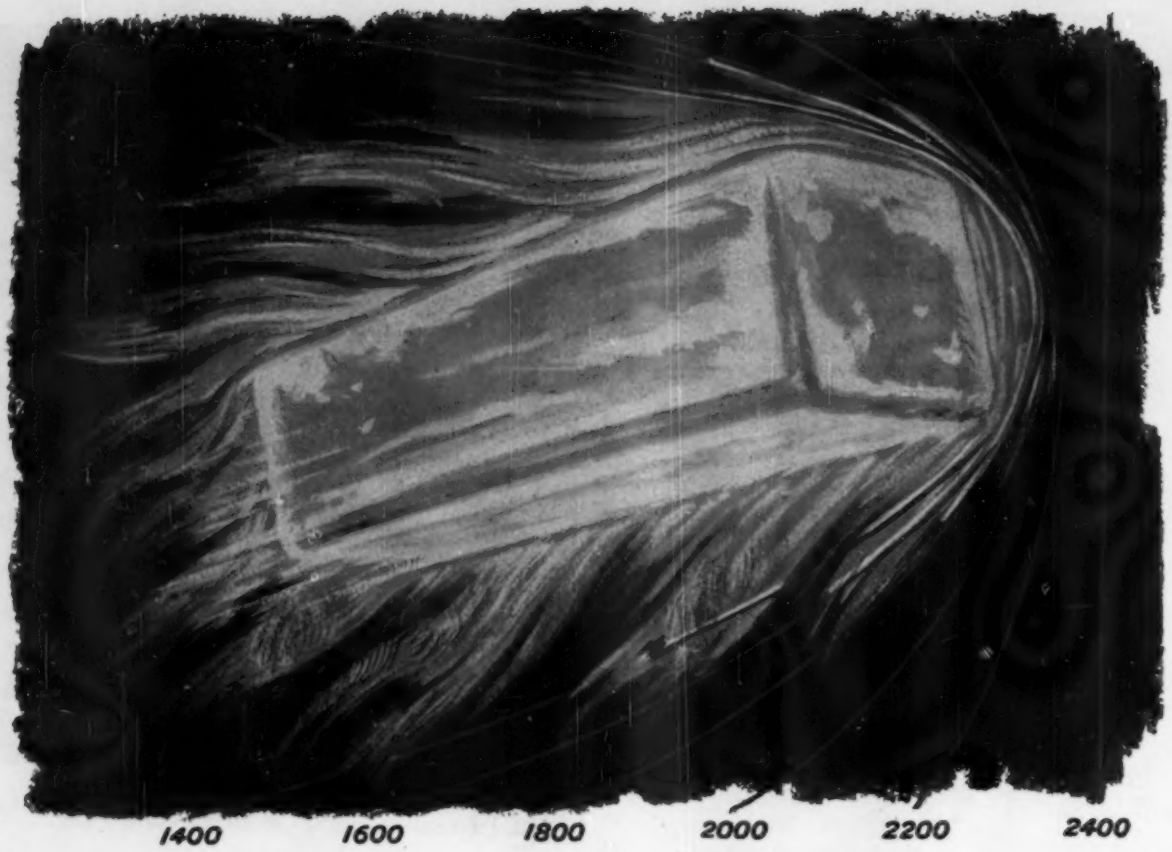
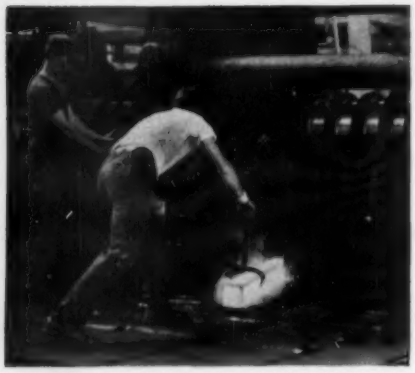


Bending the Heat Barrier



Specialized mill equipment is available at HAYNES STELLITE for rolling high-temperature alloys into a variety of shapes and sizes. Bar (above) is being produced on a 24-inch mill.

High strength plus resistance to oxidation, creep, thermal shock, and fatigue—are some of the properties that have helped to push the heat barrier back over the past 15 years. These are the properties found in HAYNES high-temperature alloys. Properties that make these alloys very useful in the 1000 to 2000+ deg. F. range.

Typical uses? The really hot spots in jet aircraft, ramjets, and missiles are some. Furnace components, heat-treating equipment, kiln liners are others. In fact, any part where long service life under severe high-temperature conditions is essential.

There are 12 HAYNES high-temperature alloys—available immediately in convenient forms that can be readily fabricated. For information on properties and prices, write for descriptive literature.

HAYNES
ALLOYS

HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

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Research: opens the door to space

Space Technology Laboratories is responsible for the over-all systems engineering, technical direction, and related research for the U.S. Air Force Ballistic Missile Programs. To carry out the fundamental investigations of those physical phenomena related to very advanced and long-range problems of space technology, STL established the Physical Research Laboratory.

This laboratory is making significant contributions in experimental and theoretical research in the fields of controlled fusion and associated plasma physics, magnetoaerodynamics and low temperature solid state physics.

Dr. Milton U. Clauser, Vice President of the Company and Director of STL's Physical Research Laboratory, draws upon a rich background of industrial, as well as academic, experience and achievement in charting the areas of research that will be important to the space technology of the future.

The professional staff of the Physical Research Laboratory, the majority of whom hold the Doctorate, are supported by unusual shop facilities and a complete staff of technicians. Also available is an outstanding digital computing center within the STL complex. Scientists and engineers with competence and imagination in fields related to advanced cryogenics, fusion physics and magnetohydrodynamic investigation, are invited to inquire about Staff positions.

Space Technology Laboratories, Inc.

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- LINEARITY 0.5% OF FULL-SCALE
- COMPLETELY TRANSISTORIZED
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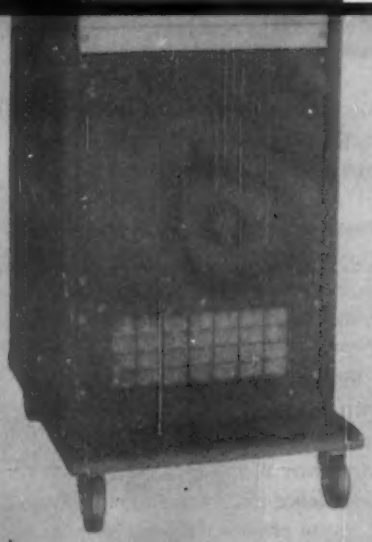
- VELOCITY FEEDBACK DAMPING
- GAIN STABILITY BETTER THAN 1%
- 9 ELECTRICALLY CONTROLLED CHART SPEEDS

6 or 8 channels of sharp, inkless traces in true rectangular coordinates

in a new, simplified . . .

5-VOLT FULL-SCALE SANBORN RECORDING SYSTEM



8-Channel Model 358-5480 Oscillographic Recording System . . . 6-Channel Model 356-5480 also available.

This new Sanborn direct writing system provides six or eight channels for computer readout, telemetry recording, DC voltage monitoring and similar applications where 0.1 volt/div sensitivity is sufficient and no preamplification is needed. The input impedance is 100,000 ohms. Frequency response is 3 db down at 100 cps at 10 div peak-to-peak amplitude; hysteresis is less than ±0.1 div. A 17½" Recorder-Amplifier-Power Supply package displays 8" of chart, locks in or out, loads easily from the front, has a built-in footage indicator and take-up, and can be completely remote-controlled. Galvanometers are rugged, low impedance, low voltage units with enclosed construction. The 5¼" Control Panel provides front and rear inputs, attenuator ratios of 1, 2, 5, 20 and 50, internal 2-volt calibration signals, position and smooth gain controls. The system is available in either the 60" mobile cabinet as shown (complete with power panel, wiring harness and built-in blower) — or as separate Recorder-Amplifier-Power Supply and Control Panel units for rack mounting.

Find out what this new system can do for *you*. Ask your local Sanborn Industrial Sales-Engineering Representative for complete facts — or write the Industrial Division in Waltham.

See this new System at the I.R.E. Show — Booths 3601-03-05

SANBORN COMPANY

175 Wyman Street, Waltham 54, Mass.

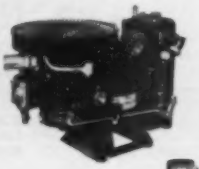
Circle Number 5 on Reader-Service Card

367 SYSTEM COMPONENTS

Compressors — Will deliver from 0.5 to 10 SCFM at pressures up to 3000 psi, through a full range of altitudes and temperatures. Choice of hydraulic, AC, DC or engine drive. Smallest, lightest and coolest running of any made.

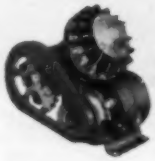
Pressure Switches — Both low and high pressure. Gage or absolute type. Pneumatic or hydraulic. Normally open or closed. Full range of differentials.

Pressure Regulators — Precise regulation from 2 to 2000 psi, with inlet pressures up to 3000 psi and capacities up to 150 SCFM. Both absolute and gauge types available.

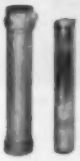


Compresser Packages — Complete pneumatic systems based on Cornelius compressors, include inlet air filter, starting relay, radio noise filter, moisture separator with automatic condensate dump and heating element, back pressure valve, check valve, relief valve and pressure switch.

Pressure Relief Valves — Compactness with accurate settings from .5 psi to 4000 psi. Vacuum and combination pressure-vacuum models also available.



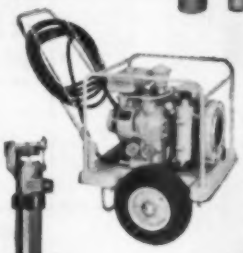
Pressurization Pumps — Weight 4 lbs. with explosion-proof AC or DC motors. For pressurizing de-icer and water systems, electronic equipment, hydraulic and fuel reservoirs. Rated at 1 CFM of free air at 25 psig and altitudes up to 50,000 ft. Available as complete system with check valve, relief valve, pressure switch, and dehydrator.



Chemical Driers — 3000 psi service. Long life desiccants. Capable of operating up to 275° F. Rated for dew points down to —65° F.

Air Storage Bottles — Lightweight aluminum construction, rated up to 2000 psi, these reservoirs meet MIL-C-7905A with weights as low as 2 lbs.

Emergency Air Brake Valves — Metering type designed for sensitive hand or foot operation with inlet pressures up to 3000 psi and brake pressures up to 2000 psi.



Portable Compressors — Complete, compact, ground support systems. Weigh less than 100 lbs. Pressures up to 4000 psi. Air delivery up to 5 SCFM. Ideal for missile, aircraft or "retriever" service. Industrial versions for OEM, shop and lab use.

Moisture Separator Assemblies — Complete 3000 psi system assemblies consisting of integral pressure switch, relief valve, check valve, automatic solenoid operated dump valve and thermostatically controlled heating element.

Hydraulic Motors — Long life, rugged, 3000 psi motors for Type II systems. Features completely new Cornelius design.

Anti-G-Valves — Government standard equipment, meets AN-6538 specification.

AC and DC Motors — Explosion-proof, light weight, continuous duty. For operation within full range of altitudes and temperatures.

Hydraulic Pumps — exclusive Cornelius design for 3,000 psi Type II systems. Both variable and fixed displacement.

there are dozens of Cornelius products for designing better pneumatic and hydraulic systems

To be exact, there are 367 products made by The Cornelius Company to help you design better pneumatic systems. Their prime characteristic is reliability. Here's why. Each Cornelius product has an extra margin of built-in safety to protect it against the effects of shock, vibration, temperature, pressure and contamination. Rigorous testing helps assure first class performance and maximum longevity. If your system designs call for these or related pneumatic components you'll find Cornelius quality and dependability will be valuable in helping you maintain a high level of performance. For specific information about any Cornelius product, talk with a Cornelius sales engineer or write direct to The Cornelius Company.

THE *Cornelius* COMPANY

AERO DIVISION

554 • 39th Avenue N. E. • Minneapolis 21, Minnesota

Pioneers in pneumatic systems for aircraft.

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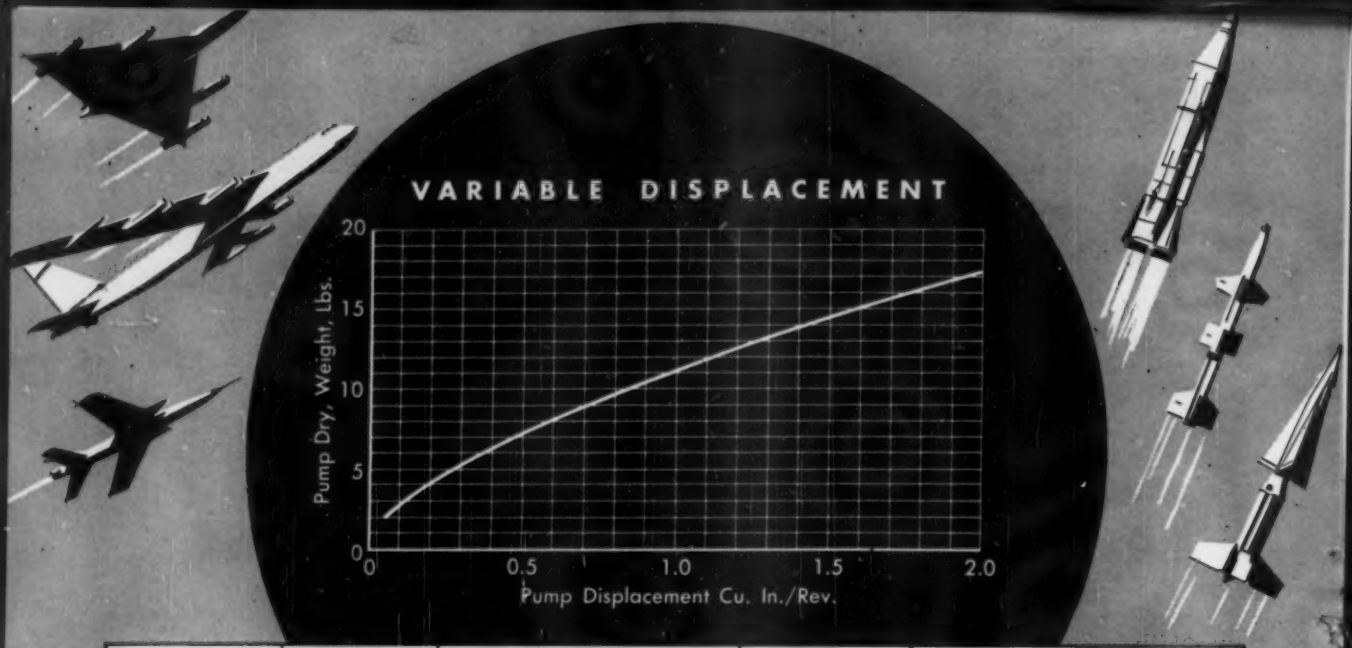
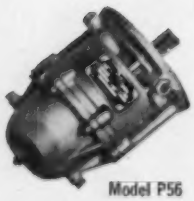


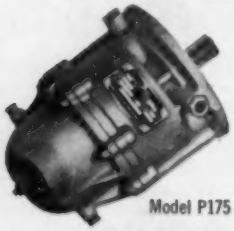
Model	Displacement In 3/Rev	Rated		Max. RPM	Envelope Dimensions	
		RPM	GPM		Diameter	Length
P175	1.750	4000	29.4	5000	5.750	8.320
P105	1.050	4000	17.3	6000	5.250	7.250
P56	.568	6000	13.9	8000	4.687	6.625
P16	.163	12000	7.9	16000	3.000	4.250
P11	.115	12000	5.5	16000	2.750	3.625
P064	.064	12000	3.1	18000	2.125	3.125
P044	.044	12000	2.1	18000	2.125	3.062

A NEW FAMILY OF . . . HYDRAULIC PUMPS WITH THE LOWEST WEIGHT DISPLACEMENT RATIO

For Aircraft, Missiles, and Systems!



Model P56



Model P175

This new family of rotary plunger pumps is furnished with forged aluminum housings for fluid operating temperatures to 400°F. Thousands of hours of endurance and qualification testing, as well as flight tests, have proven that these new pumps will satisfactorily handle all MIL specification hydraulic fluids including Oronite 8515 and will exceed MIL-P-19692 specification requiring 750 hours of endurance. The low weight displacement ratio is accomplished by utilizing space not available in other designs to incorporate the variable displacement feature and servo system. Plungers operate on an inclined axis to provide centrifugal return force and are arranged such that the side loading on each plunger is minimized when the maximum overhung moment occurs.

Fixed displacement pumps are also available in all models with reduced weight and envelope dimensions.

The proven experience of Bendix in manufacturing thousands of direct injection pumps and fuel systems for reciprocating engines, fuel supply pumps, fuel systems for turbine engines, hydraulic pumps, and hydraulic systems for high performance missiles assures you of a quality unit or system meeting the high reliability standards of the industry.

FOR 3000 AND 4000 PSI
SPEEDS TO 18,000 RPM

MAJOR PRODUCTS—aircraft and missile hydraulic pumps; hydraulic components and sub-systems; engine fuel pumps and fuel system components; precision bellows and bellows assemblies; thermostats and related sub-assemblies; and sub-contract manufacturing and brazing.

Hamilton Division
HAMILTON, OHIO

Bendix
AVIATION CORPORATION

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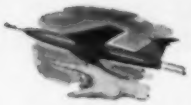
What does it take to create a complete

Missile Weapon System?

WEAPON SYSTEM: A definition

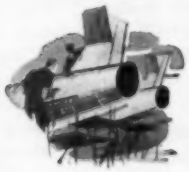
"A system composed of equipment, skills and techniques, the composite of which forms an instrument of combat, usually . . . having an air vehicle as its major operational element. The complete weapon system includes all related equipment, materials, services, and personnel required solely for the operation of the air vehicle . . . so that the instrument of combat becomes a self-sufficient unit of striking power within its intended operational environment."
— Quoted from Defense Department Regulations



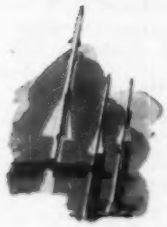
GUIDANCE
— of the accuracy of ATRAN, and the even newer PIN-POINT with much greater accuracy for guiding American missiles.

RADOMES
— exterior structural plastic housing for a missile's electronic eyes. Goodyear Aircraft is a pioneer and leading producer of such housings.

RADAR
— Goodyear Aircraft builds hi-performance airborne systems and large radar structures for early warning, missile guidance and tracking systems.



AIRFRAMES
— fabricated of the newest alloys by the most advanced techniques. Goodyear Aircraft has decades of light-metals experience in airship pioneering, building thousands of complete airplanes and structures for today's jet aircraft and missiles.



ROCKETS
— to propel the missiles skyward. Goodyear Aircraft has built more large-size rocket cases than any other manufacturer.

GROUND SUPPORT EQUIPMENT
— to check the missile's design characteristics, the complete system's performance—to move, maintain, launch a squadron's missiles. Goodyear Aircraft designs and builds this equipment, and has created today's foremost mobile missile ground support system.

COMPUTERS AND FLIGHT SIMULATORS
— to check the missile's initial design characteristics and simulate its flight. Goodyear Aircraft builds GEDA, an analog computer, and supplies flight simulators for the military services.

UNIFIED ENGINEERING
— to solve the technical complexities of creating a complete system. Goodyear Aircraft has a Weapon System Engineering organization—specialists with a unified approach to, and complete familiarity with, the total problem.

PRODUCTION FACILITIES
— to tie together and produce the whole concept. Goodyear Aircraft maintains facilities in Akron, Ohio, and Litchfield Park, Arizona, where 12,000 skilled people work—*To Keep America First In The Air.*

GOODYEAR AIRCRAFT

ATRAN, GEDA, PIN-POINT—T. M.'s Goodyear Aircraft Corporation, Akron 15, Ohio

Plants in Akron, Ohio, and Litchfield Park, Arizona • Rewarding Challenges and Careers for Engineers

Circle Number 8 on Reader-Service Card

What You Should Know About This Symbol...

It may be new to you now, but you'll see it again and again. It's a symbol of service to government, the armed forces, to defense industry.

For it represents The Singer Manufacturing Company's *Military Products Division*, a functional team of three well known organizations—Haller, Raymond & Brown, Inc., Diehl Manufacturing Company, and Singer-Bridgeport.

The Military Products Division provides scientists and engineers familiar with government requirements . . . development and production facilities for making systems, products, and components in large quantities, at a practical cost.

It can handle projects from concepts to production, or serve defense industry capably as a subcontractor —in any of three ways—by developing to requirements, building to specifications, or by supplying a product line. Remember this symbol. It can serve you well. *The Singer Manufacturing Company, Military Products Division, 149 Broadway, New York 6, N. Y.*

THE SINGER MANUFACTURING COMPANY

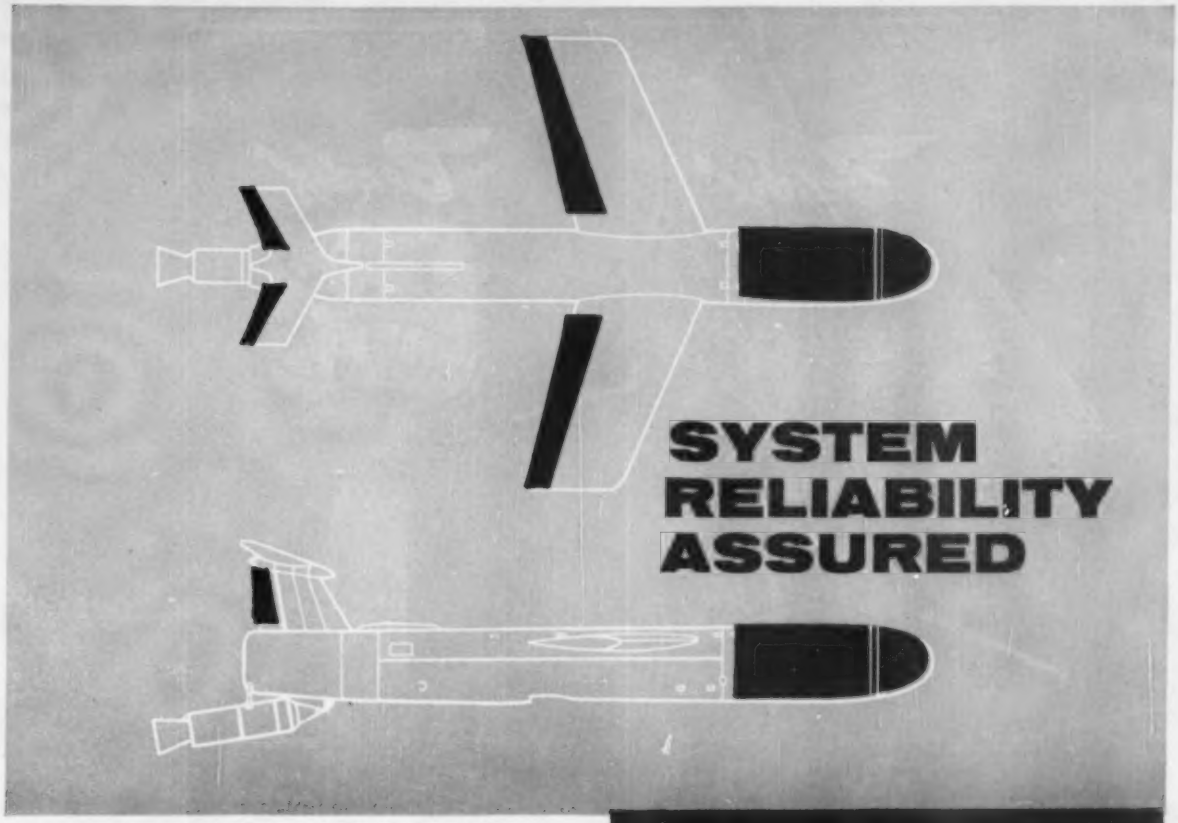
Military Products Division

149 BROADWAY, NEW YORK 6, N. Y.

*A TRADEMARK OF THE SINGER MANUFACTURING COMPANY

SINGER MILITARY PRODUCTS DIVISION

Circle Number 9 on Reader-Service Card



WITH MAGNETIC AMPLIFIERS, INC.

SOLID STATE DESIGN

Typical of the systems designed and developed by Magnetic Amplifiers, Inc. is the Advanced Missile Checkout Equipment shown in the illustration. The equipment is an alignment and final checkout instrument which performs complete static gains and dynamic responses on the MACE AUTOPILOT with an accuracy of better than ±.2%. Over 200 separate tests are performed in sequence.

The success of this equipment for missile equipment checkout, is due to its inherent reliability, human engineering, functional flexibility, and simplicity of operation with no maintenance.

In order to achieve a continuous link of Reliability from design through production, Magnetic Amplifiers, Inc. maintains a disciplined Quality Control System.

MISSILE CHECKOUT EQUIPMENTS
STATIC PROGRAMMERS AND SEQUENCERS
STATIC POWER/LOGIC SWITCHING SYSTEMS
COUNT-DOWN EQUIPMENT

Inquiries are invited concerning your requirements. Engineering conferences at your or our facilities can be arranged. Write—call or wire

MA

MAGNETIC AMPLIFIERS, INC.

632 TINTON AVENUE
NEW YORK 55, N. Y.
CYPRESS 2-6610

136 WASHINGTON STREET
EL SEGUNDO, CALIFORNIA
OREGON 8-2565

Circle Number 10 on Reader-Service Card

ACTUAL SIZE

RA-21A VHF RECEIVER. 560 channels (50 kc spacing). Short ¼ ATR package. Provides r-f and audio circuitry for NVA-21A Navigation Unit.

NVA-21A NAVIGATION UNIT. Provides complete automatic VOR and LOCALIZER operation. Short ¼ ATR package. Completely transistorized.

The Smallest, Lightest and Finest in VOR/LOC Equipment for business and airline aircraft.

For further information write

Bendix Radio Division

Baltimore 4, Maryland

Bendix
AVIATION CORPORATION

Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Cuts the time and cost lag between

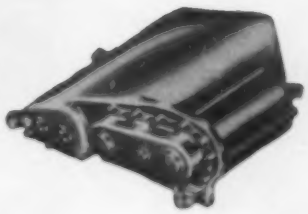
development and production

With each new design STRATOPOWER packs more and more performance into less and less space. This is evident in the equipment itself.

Less evident but no less true is the fact that each year STRATOPOWER is delivering more and more development results and production items in less and less *time*. This is because, at STRATOPOWER, contracted development is balanced with STRATOPOWER's own development effort to yield a continuous, well-rounded program of creative research in aircraft hydraulics.

No problem in hydraulics, however difficult, is ever completely dissimilar to projects already underway. The skill, tooling and materials are always at hand, whether the need is for testing at 1200°F (1200°F facilities were installed at STRATOPOWER early in 1958), production of a simple constant delivery pump (shipped by the thousands by STRATOPOWER), or development of a compact, complex hydraulic power package (such as the one shown in the accompanying illustration).

Talk to your STRATOPOWER representative. You may be surprised to hear him telling you what your hydraulic problems will be a year or two years from now. He knows, because STRATOPOWER is already there, anticipating the needs of the aircraft industry. It's no secret how STRATOPOWER licks the time lag to shrink the 4th dimension.



At STRATOPOWER, all lag-generating problems are solved yesterday.

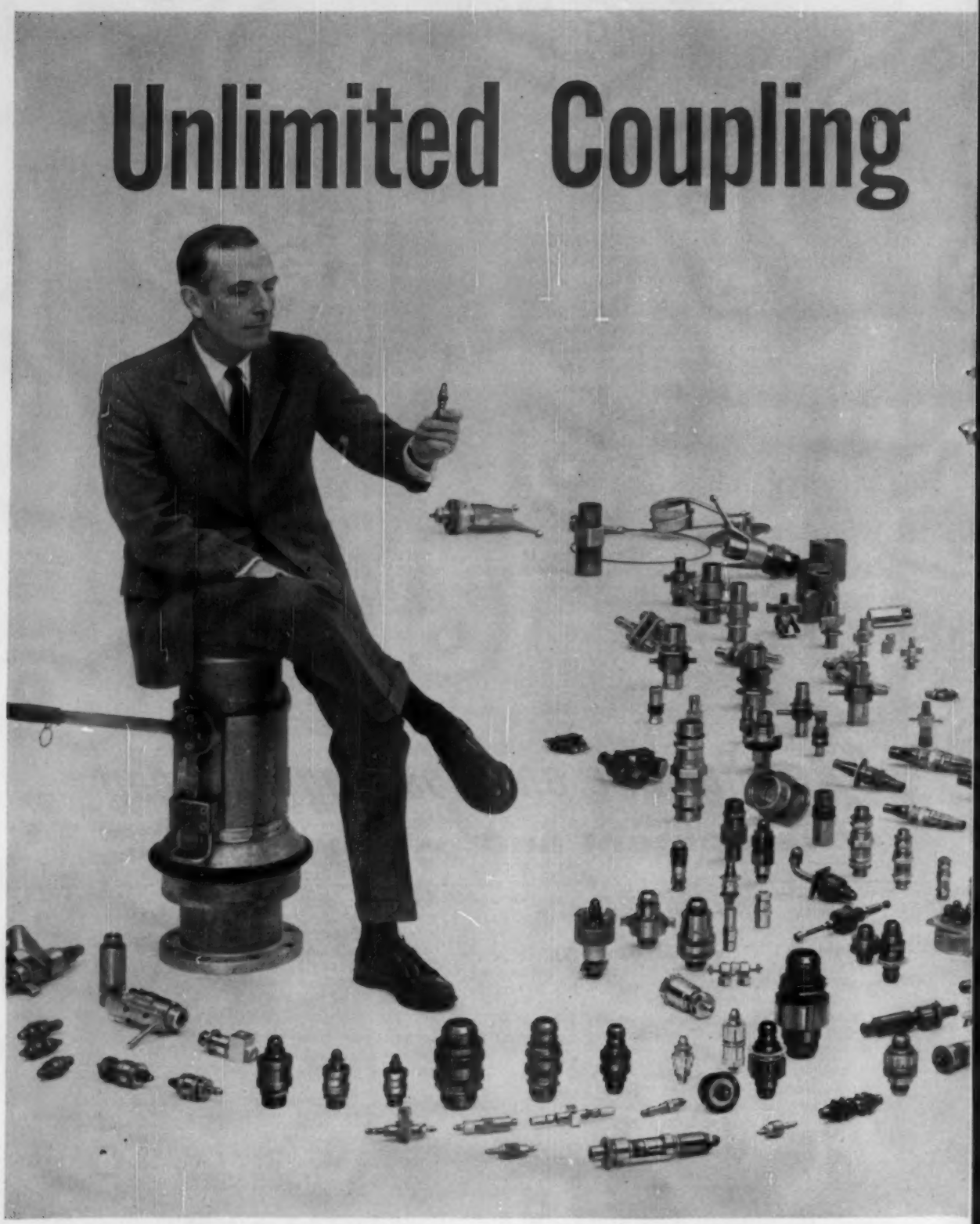
LOS ANGELES OFFICE
The New York Air Brake Company
5058 Venice Boulevard
Los Angeles 19, California

DALLAS OFFICE
The New York Air Brake Company
6211 Denton Drive
Dallas, Texas

SEATTLE OFFICE
The New York Air Brake Company
Post Office Box 318
Bellevue, Washington

WATERTOWN DIVISION
THE NEW YORK AIR BRAKE COMPANY
STARBUCK AVENUE • WATERTOWN • N. Y.

Unlimited Coupling



Tremendous range of Aeroquip Coupling designs is demonstrated by B. A. Main, Jr., Vice President of Engineering, seated on a 10-inch coupling while holding a miniaturized coupling in his hand. The couplings shown here are only a few of the infinite variety developed by Aeroquip for use with hydraulic fluids, ordinary and exotic fuels, gases, oils, air, liquefied gases, ammonia, nitric acid, ethylene oxide and many other fluids.

Circle Number 13 on Reader-Service Card

Designs!

WITH A WEALTH OF EXPERIENCE PLUS UNMATCHED FACILITIES, AEROQUIP DESIGNS, TESTS AND PRODUCES COUPLINGS TO MEET YOUR SHORT LEAD-TIME REQUIREMENTS

Call on Aeroquip for the solution to your fluid coupling problem. Let us know your requirements on fluid, temperature, pressure, size and application, and Aeroquip will recommend, design and produce the coupling that meets your needs . . . and do it FAST!

This is the service that Aeroquip is especially well qualified to provide for manufacturers of missiles, aircraft and accessories and components.

Years of experience gained in building millions of couplings enables Aeroquip to approach your problem with complete knowledge and understanding. Development facilities include extraordinary engineering depth plus extensive laboratory, shop and test equipment. Production and quality control facilities are the finest and most modern in the industry.

At Aeroquip, coupling designs and facilities are UNLIMITED!

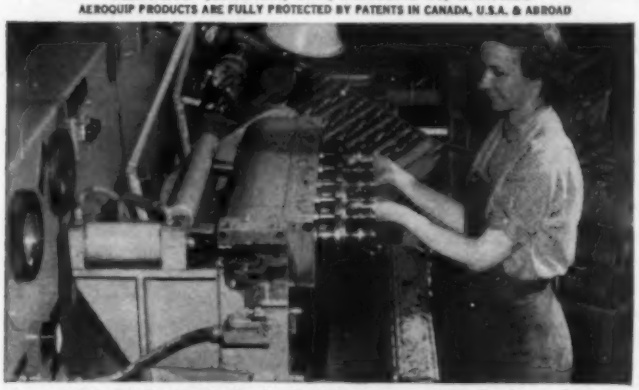
Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN
AEROQUIP CORPORATION, WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. & ABROAD

Birthplace of many new coupling designs is this modern design section in Aeroquip's development-engineering center at Jackson, Mich. Another engineering staff is maintained at the Western Division in Burbank, Calif., which also produces couplings.

Testing equipment that duplicates conditions ranging from arctic cold to the searing heat generated by jet or rocket engines in flight is included in the development-engineering section, at Jackson, which occupies over 15,000 sq. ft. of floor space.



Aeroquip's high standard of reliability is assured by final proof testing of all couplings. The proof test machine pictured above was specially designed by Aeroquip for maximum dependability and speed. Final testing follows numerous quality control checks during production.

Production facilities in the Jackson plant include this battery of automatic screw machines. Complete manufacturing operations are duplicated in Aeroquip's Western Division plant.

FILL IN AND RETURN THIS COUPON FOR COMPLETE COUPLING INFORMATION AW-3

Aeroquip Corporation, Jackson, Michigan
Please send me further information on Aeroquip Couplings. I am chiefly concerned with the following:

Fluid to be used_____

Temperatures from_____° to_____°.

Pressures from_____psi to_____psi.

Size_____I.D. Operation ☐ manual ☐ remote ☐ other

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

New B.F. Goodrich Lightweight De-Icers FAA-approved for Cessna 310

THE NEW Federal Aviation Agency has granted a Supplemental Type Certificate No. SA1-293 for the unique B. F. Goodrich Lightweight Pneumatic De-Icer system on all models of Cessna 310 aircraft.

Operating on a closed system of compressed air, this new Lightweight De-Icer is the first and only practical, low cost ice protection ever developed for light planes. There are no electrical connections, and weight, complete, is approximately 50 pounds.

Source of compressed air is a compact reinforced plastic accumulator that can be removed for extra load capacity during summer flying. The accumulator is guaranteed for 10,000 recharges at 3,000 psi. At this pressure the system provides enough energy for 6 to 7 hours of positive de-icing action when operated on a 3-minute cycle.

A complete kit is now available for all models of Cessna 310 aircraft—and kits for other light twin planes will be available soon. Completely FAA-approved, the system will perform satisfactorily between –65°F. and 200°F. Cycle and time life is the same as for B. F. Goodrich De-Icers used on the largest aircraft.

Contact your local B. F. Goodrich Aviation Products distributor and see how easily you can equip your own plane with this low cost ice protection. Or write *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. AW-39, Akron, Ohio.*

B. F. Goodrich Aviation Products Distributors

AIRCRAFT PARTS CO.
Atlanta, Georgia

AIRWORK CORPORATION
Atlanta, Georgia
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Dallas, Texas
Denver, Colorado
Kansas City, Kansas

B.F.Goodrich ***aviation products***

Circle Number 56 on Reader-Service Card

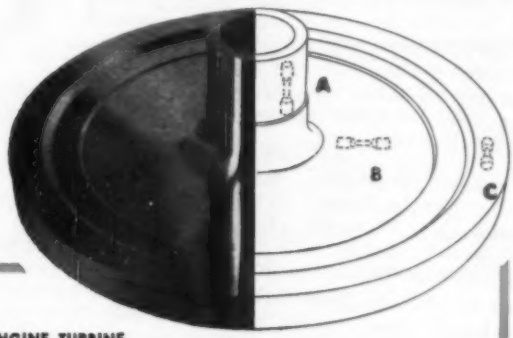
INSIDE A

CAMERON FORGING

Unique Metallurgical Properties

AMS-6407 LANDING GEAR COMPONENT MUST WITHSTAND UNUSUAL STRESSES.

		Typical Properties			
		Tensile Strength	Yield Strength	Elongation	Reduction of Area Transverse
A	Tube, Transverse	236,000	203,000	12.7%	45.1%
B	Fork, Transverse	233,000	205,000	10.6%	31.9%



A-286 JET ENGINE TURBINE WHEEL OF SPECIAL ALLOY MEETS UNUSUAL DEMANDS.

		Typical Properties			
		Tensile Strength	Yield Strength .2% Offset	Elongation	Reduction of Area
A	Hub, Longitudinal	158,000	117,000	22.2%	40.0%
B	Web, Radial	159,000	116,000	21.3%	40.0%
C	Rim, Tangential	162,000	117,000	20.3%	39.7%

UNIFORMLY FINE GRAIN SIZE and uniformly high properties from center to surface are characteristic of the Cameron technique. Intricate, unusual, or conventional shapes are produced in a single heat.

INCREASED TRANSVERSE DUCTILITY—several times above normally expected values. Transition from billet to final shape results in movement of metal under high internal pressure.

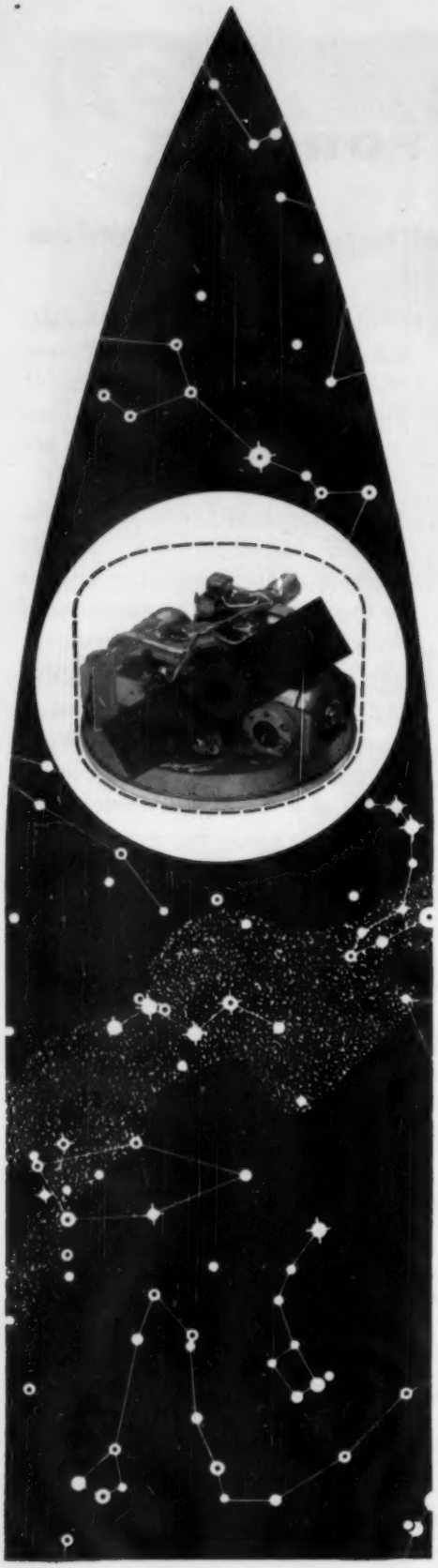
HIGH ULTRASONIC STANDARDS are consistently met by internal working of the metal which breaks up segregated material inherent in the center of steel and high density alloys.

PARTING LINE PROPERTIES-The totally enclosed method of forging, eliminating a flash line, avoids flash line magnetic indications and the localizing effect of the flash grain on transverse, fatigue, and stress rupture properties.

Extreme service components for airframes, jet engines, guided missiles and a wide variety of other end uses are finding a solution in the Cameron split-die forging process. If you have a problem . . . call, write or come by

Cameron
IRON WORKS, INC.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas



For high reliability under extreme environmental conditions, specify

Clary Gyros

The Clary CD 600 electrically driven amount gyroscope is a self-contained, three-gyro package consisting of three gyros mounted on a single bracket with pick-offs between the outer gimbals and the frame. It may be used either to control flight, or to transmit changes in pitch, yaw and roll attitudes. The entire unit is hermetically sealed and filled with dry helium. To withstand high acceleration and extreme vibration, and to insure maximum reliability, the CD 600, like all Clary gyros, is ruggedly designed, precision-manufactured and extensively tested.

GENERAL SPECIFICATIONS

Weight: DC system, 19.25 lbs.; AC system, 15.0 lbs.
Pick-off: Potentiometer or synchro.
Power Requirements: 27 V DC; 115 V AC.
Vibration: 10g at 20 to 2000 cps. • Warm-up Time: 2 minutes maximum.
Gimbal Freedom: Outer gimbal, 360° (continuous); inner gimbal, ±85°.
Drift Rate: Scorsby test .5° per 5 minutes.
Caging Operation: Remote electrical caging and uncaging control.
Temperature: −30°F to +160°F. • Altitude: No effect on operation.
Humidity: No effect on operation. • Size: Diam. 10", depth 6⅜".

The Clary CD 750 electrically driven amount gyroscope is primarily designed to control attitude of short range "artillery type" missiles such as the Corporal, Sergeant and others within the 500 mile range, where vibration and steady state accelerations are moderate to heavy. Separate pick-offs are provided for each axis, and the instrument incorporates a DC solenoid-operated caging mechanism to orient the gimbals with respect to the mounting surface. Internal atmosphere is −75° F dew point nitrogen with helium tracer at a pressure of 15 p.s.i.a.

GENERAL SPECIFICATIONS

Weight: 5 lbs. • Pick-off: Potentiometer or synchro.
Power Requirements: 115 V line to line, 400 cps, 3-phase power.
350 ma starting current, 70 ma running current.
Vibration: 10g at 20 to 2000 cps. • Warm-up Time: 2 minutes maximum.
Gimbal Freedom: Outer gimbal, 360° (continuous); inner gimbal, ±85°.
Drift Rate: Scorsby test. *Heavy rotor:* .5° per 5 minutes.
Light rotor: .5° per minute.
Caging Operation: Remote electrical caging and uncaging control.
Temperature: −30°F to ±160°F. • Altitude: No effect on operation.
Humidity: No effect on operation. • Size: Diam. 4¾₁₆", depth 5¹⁵⁄₁₆".

Clary

CLARY DYNAMICS
Dept. W-58, San Gabriel, California

Circle Number 15 on Reader-Service Card

Johns-Manville announces new **MIN-KLAD** Insulation!

This one new product answers 4 basic thermal and mechanical requirements
low conductivity
high heat capacity plus erosion resistance
high strength
Asbestos-reinforced plastic
Min-K insulation

New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is lower than any other known insulation. Actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface . . . or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Circle Number 16 on Reader-Service Card

Sustained operating temperatures up to 400° F, as in guided missiles, are death to inferior electrical insulations and laminates. CDF glass-base laminates of Teflon*—the only laminates of their kind approved by the military—can take this punishment steadily.

LATEST HIGH-HEAT INSULATION SYSTEMS NEED CDF GLASS-BASE LAMINATES AND TAPES

Widest available range offers Teflon, epoxy, silicone, mica products for dimensional stability under continuous heat

As components and equipment grow smaller, and heat becomes more difficult to dissipate, CDF high-heat electrical insulations become increasingly important to electronic design. For nowhere else can such a wide range of quality insulations be found under one roof as at CDF.

FOR HIGH-HEAT PRINTED CIRCUITRY, CDF glass-base Di-Clad® laminates of Teflon* and epoxy exhibit best dimensional stability and current-carrying capacity. Constant operating temperatures of 300° F—soldering temperatures to 500°F—are readily met by these specialized CDF Di-Clad laminates.

HIGH-HEAT FLEXIBLE INSULATIONS. CDF offers a wide choice of insulating tapes made of Teflon, silicone varnish, silicone rubber, and Micabond®, with glass-cloth support. CDF tapes may be used either by hand wrapping or on automatic winding machines. Unsupported Teflon in colors available to meet MIL-STD 104.

TEFLON SPAGHETTI TUBING AND OTHER SPECIALTIES. Part of CDF's vast fabrication facilities is devoted to the production of custom parts from Teflon — spaghetti tubing, rods, sheets, and machined parts to rigid specifications.

NEW — *cementable* Teflon, bondable to itself and to other materials with commercial adhesives.

SEE SWEET'S Product Design File, Electronics Buyers' Guide, and other directories for the name and phone number of your CDF sales engineer. Then send your print or your problem, and we'll recommend the proper material for the application.

*trademark of DuPont tetrafluoroethylene resin

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Bird COMPANY • NEWARK 20, DEL.

Circle Number 17 on Reader-Service Card

forging a renaissance in COPPER

THE BETTMANN ARCHIVE

Forging "new metals" has been routine procedure at Wyman-Gordon for 75 years. Contrasting the modern marvels of metallurgical development is the oldest metal employed by man—copper. Here you see the largest copper closed die forging ever produced—a Re-entry Shield weighing 1875 pounds (67-1/2" x 21-1/2"). Unexcelled know-how, with the availability of the most modern forging equipment, assures the ultimate in forging quality to meet the constantly expanding demands of progress—man's quest for greater speeds and power in his unending exploration farther and farther into yesterday's unknown.

WYMAN-GORDON COMPANY

Established 1883

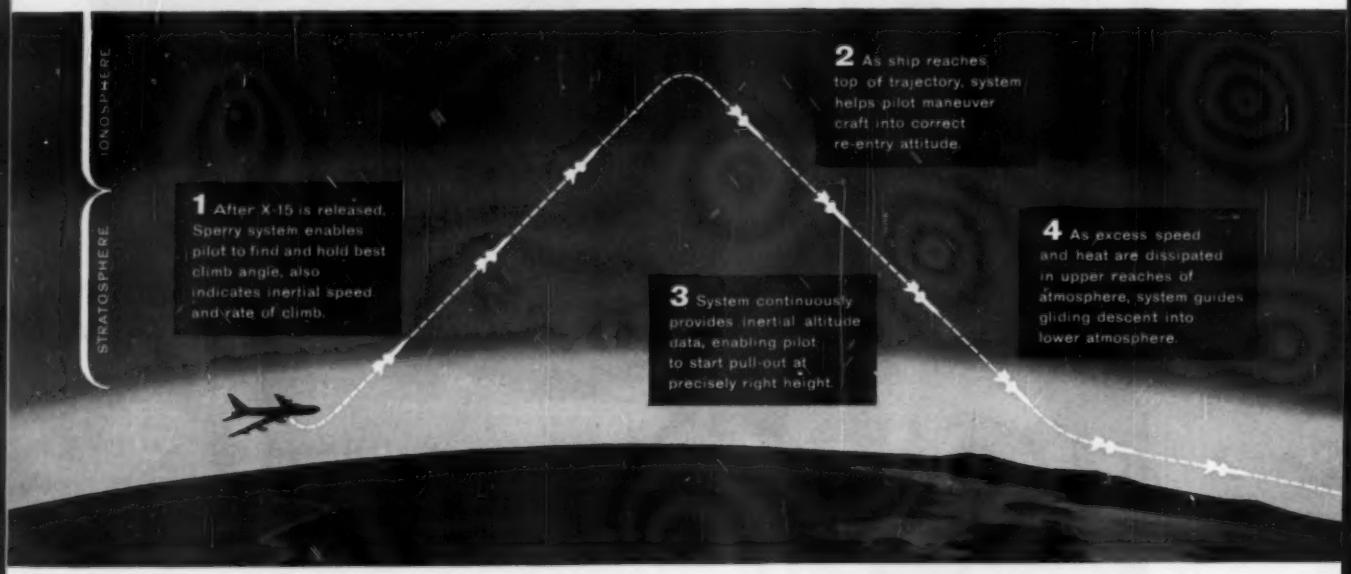
FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM
Also Beryllium • Molybdenum • Columbium and other uncommon materials

WORCESTER 1, MASSACHUSETTS
HARVEY, ILLINOIS • DETROIT, MICHIGAN

Circle Number 18 on Reader-Service Card

HYPERSONIC X-15, powered by a mighty rocket engine, will follow bullet-like trajectory during flight, similar to path of ballistic missile.

WEARING SPECIALLY-DESIGNED SPACE SUIT, X-15 pilot is protected against environmental extremes as he maneuvers the rocket to the edge of space.


IONOSPHERE
STRATOSPHERE
1 After X-15 is released, Sperry system enables pilot to find and hold best climb angle, also indicates inertial speed and rate of climb.
2 As ship reaches top of trajectory, system helps pilot maneuver craft into correct re-entry attitude.
3 System continuously provides inertial altitude data, enabling pilot to start pull-out at precisely right height.
4 As excess speed and heat are dissipated in upper reaches of atmosphere, system guides gliding descent into lower atmosphere.

X-15 WILL THRUST 100 MILES INTO SPACE UNDER CONTROL OF NEW INERTIAL SYSTEM

Strapped firmly into his cockpit, an Air Force pilot soon will ride the North American X-15 rocket research ship 100 miles and more into the sky at speeds above 3600 mph—over a mile a second.

A highly advanced Sperry inertial system, developed in conjunction with the Flight Control Laboratory of Wright Air Development Center, will supply control data for this historic venture. When the pilot and his revolutionary craft drop from a B-52 jet bomber, the inertial system will give him data for maneuvering and navigating the X-15 with extreme accuracy. As the stainless steel research plane flashes outward through the thinning atmosphere, the Sperry system will "show" the pilot how to correct for even the smallest deviation from flight path. It will display flight information on specially developed instruments; at the same time feeding the data to ground and airborne recorders for a permanent record of the flight.

An important additional contribution of the Sperry system will be to guide the pilot in bringing the X-15 safely back into the earth's atmosphere. During this critical phase of the flight, attitude of the X-15 on re-entry must be precisely controlled to avoid exceeding its structural limitations.

On this daring journey into space, the super-sensitive Sperry system will have to function perfectly under conditions ranging from extreme acceleration to complete weightlessness, through temperature swings that may heat the X-15's exterior to 1,000 degrees in a few seconds.

SPERRY GYROSCOPE COMPANY
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION

THIS IS THIOKOL...

serving industry and the national defense

In modern plants strategically situated throughout the country, Thiokol is making many significant contributions to the art and science of rocketry.

By developing new and better propellants (both solid and liquid)—by designing and building improved power plants to utilize these fuels—by furnishing essential support equipment . . . Thiokol helps to strengthen the nation's defenses, helps push back our spatial frontiers.

Engineers, Scientists: perhaps there's a place for you in Thiokol's expanding organization. Our new projects present challenging problems and a chance for greater responsibility.

Thiokol® CHEMICAL CORPORATION

TRENTON, N. J. • ELKTON, MD. • HUNTSVILLE, ALA. • MARSHALL, TEXAS
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®Registered trademark of the Thiokol Chemical Corporation for its liquid polymers, rocket propellants, plasticizers and other chemicals

←Circle Number 19 on Reader-Service Card

Circle Number 20 on Reader-Service Card

SINGLE-GUN COLOR TUBE RETROFITS!

We've been hearing comments that have the ring of praise about them. They have been comments on the simplicity of our Lawrence-type color display tube, 5CGP29. We build other color and monochrome cathode ray tubes, *e.g.*, for applications requiring high definition of a hush-hush nature, or for fine character writing and many other applications. But let us discourse on the 5CGP29.

First of all it adapts to a great many equipments now limited by monochrome. It adapts with the same yoke you are now using and without the need to build a six-foot voltage-control console. The 5CGP29 does not have fussy requirements.

Post-Deflection Focusing is incorporated in the design. The electron beam paths are directed through an array of grid wires to an aluminum-backed phosphor screen on the face of the tube. Switching voltages on adjacent grid wires change the impact point of the focused beam. None of this is particularly critical in operation. And the operating voltages are such as not to produce what the low-temperature lab men call "thermal chaos."

There is very likely nothing more dramatic in the world of electronics than the face of a 5CGP29 discriminating between different classes of information in extra dimensions with bold colors. Military people appreciate it when, again with different colors, the 5CGP29 promptly discriminates in radar between hazardous and non-hazardous objects, or between friendly and unfriendly targets, for example.

A number of commercially available phosphors, with differing responsive qualities, afford wide variations in persistence and colors. There are dozens of uses for the tube in science, industry, and the military service. Let us tell you about them. Electronic Display Laboratory, Litton Industries Electron Tube Division, Office A4, 960 Industrial Road, San Carlos, Calif.

Visit our Booths at the IRE Show

LITTON INDUSTRIES Electron Tube Division

MAGNETRONS • GAS DISCHARGE TUBES • CARCINOTRONS • TRAVELING WAVE TUBES
KLYSTRONS • BACKWARD WAVE OSCILLATORS • NOISE SOURCES • DISPLAY TUBES

CAPABILITY THAT CAN CHANGE YOUR PLANNING

FLY WEATHER-WISE — Mobil

These weather items prepared in consultation with the United States Weather Bureau

TEMPERATURE VARIATIONS

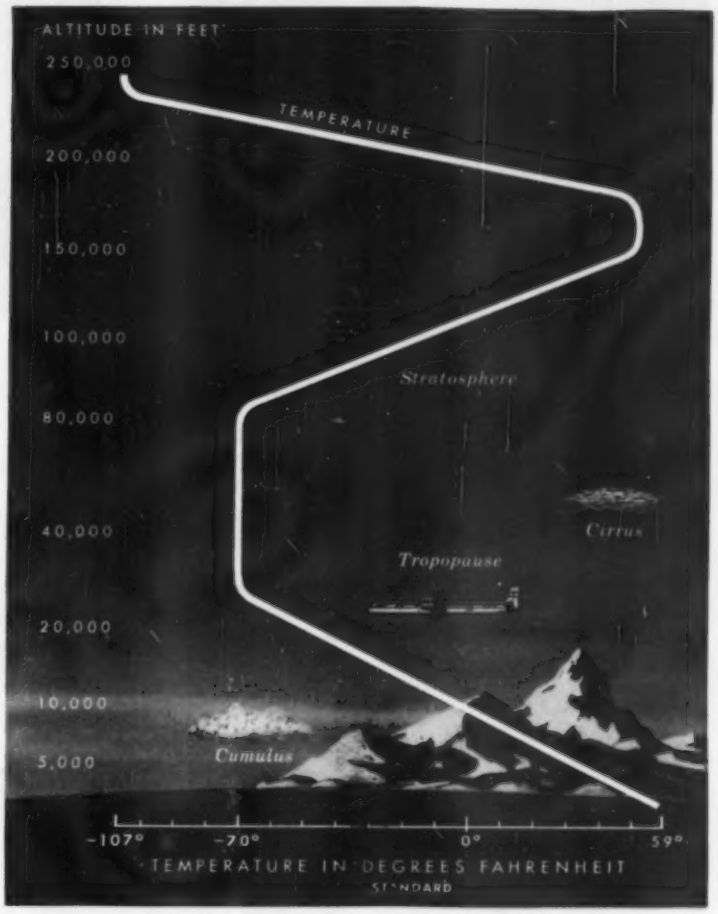
IN RELATION TO ALTITUDE...

TEMPERATURES encountered in a single flight may vary as much as 130°F. or more. These variations are associated with altitude and weather patterns and can affect flight performance.

Temperature and altitude—Heat from the earth warms the atmosphere with steadily decreasing effect as altitude increases. Temperature normally decreases with altitude at the rate of 3½°F. per 1000 ft. At the tropopause (top of troposphere) temperature remains almost constant up to 80,000 ft. Therefore, modern aircraft encounter coldest air in the tropopause layer which varies from about 28,000 ft. in the polar air masses to 54,000 ft. in the tropical.

As altitude increases from approximately 80,000 ft. to 150,000 ft., the temperature returns to almost sea level condition. This is the result of strong absorption of the sun's ultra-violet rays in the layer of ozone gas at very high altitudes.

At still higher altitudes, the temperature reverts to extreme cold.



FORECAST: *Top Flight Performance with Mobil Aero Hydraulic Oils and Mobilgrease Aero!*

Mobil

You're Miles Ahead With Mobil!

SOCONY MOBIL OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORP., MOBIL OVERSEAS OIL CO., INC.

Instant control response can be yours despite extreme temperature variations, thanks to the wide range of temperature characteristics of these top-quality Mobil products.

Mobil Aero Hydraulic Oil HF and HFA—These low pour point and high VI oils help assure trouble-free operation of hydraulic control systems, brakes and struts through all temperature ranges.

Mobilgrease Aero Lo-Temp and General Purpose—These Aero greases help assure smooth operation of all sliding and rolling surfaces of aircraft parts . . . control systems, bearings, and gears.

←Circle Number 21 on Reader-Service Card

Circle Number 22 on Reader-Service Card

There's a new kind of airplane ahead for America's new generation of pilots

Gramp raced through the skies at nearly 100 miles an hour. He flew his fabric-covered biplane by the seat of his pants and the wind in his face.

Some twenty years later, his son flew a P-51 Mustang at better than 400 mph... later on flew a Sabre Jet that approached the speed of sound. There were more dials to watch, more controls to work, till he wondered if airplane designers hadn't reached the limit of human capacity.

Today's Air Force pilots can look forward to piloting a new kind of airplane. It will fly more than 2,000 miles an hour... carry an electronic crew to navigate, find targets, fire weapons, evade attack. Most significantly, its pilot will have as much time as Gramp did to do what man does best: make decisions.

For though machines can see farther, figure faster, and react quicker than men, they cannot cope with the unexpected—nor can they be recalled or redirected. That is why America needs the judgment of men as well as the automatic deadliness of missiles. Her deterrent power will always depend on building the most advanced manned and unmanned weapon systems—and keeping them ready for action.

Three times the speed of sound

North American is now at work on two Mach 3 airplanes for tomorrow's Air Force—the B-70 bomber for the Strategic Air Command and the F-108 interceptor for the Air Defense Command.

The B-70 will skirt the edge of Space to any target on earth—*flying every mile of the way at more than 2000 mph.* It will carry the most advanced weapons, including missiles it can launch hundreds of miles from ground defenses or primary targets—plus countermeasures against enemy attack.

The F-108 will be able to detect and identify incoming airborne weapons—manned or unmanned—over 1000 miles from our shores... and destroy them.

These manned weapon systems will give true depth and flexibility to our nation's deterrent power.

Mobilizing America's best for the job

North American, as weapon system manager for the B-70 and F-108, has been charged with complete scientific, engineering, and administrative responsibility. To enlist the best brains and specialized skills of American industry, North American has divided each airplane into major subsystems, which are being awarded to the contractors best qualified to handle them.

Though these projects are among the most important ever entrusted to one company, North American's knack for turning revolutionary concepts into revolutionary airplanes is a matter of record. Time and again, North American's designers and engineers have exceeded expected performance—yet made the new airplane practical to build, fly, maintain. This sure hand—result of building more aircraft than any other company in the world—has created more air power for fewer tax dollars.

THESE FAMOUS AIRPLANES WERE READY WHEN AMERICA NEEDED THEM

Subsonic P-51 Mustang—did valiant service in World War II.

Transonic F-86 Sabre Jet—drove the MIGs from the skies of Korea.

Supersonic F-100 Super Sabre—mainstay of the Free World's fighter strength.

Hypersonic X-15—soon to carry the first American to the fringes of space.

THE LOS ANGELES DIVISION OF NORTH AMERICAN AVIATION, INC.

Hughes Falcon installed on the Northrup F-89

Basic KX4 Switch

KLIXON Precision Switches

Help Hughes Aircraft Company Obtain Maximum Reliability in Falcon Launchers

A vital weapon in the arsenal of the U. S. Air Force is the Hughes Falcon air-to-air missile. And in the Falcon Launchers, as in other armament control systems, guided missiles and operational aircraft, KLIXON Precision KX4 Switches play an important role in assuring dependability of operation.

These KLIXON Switches, manufactured to exacting tolerances, are used in Falcon Launchers to indicate proper loading and firing of the missiles.

KLIXON Precision Switches are ideal for applications of this type. They are enclosed in a strong steel case capable of withstanding heavy impact and compression loads. True hermetic sealing is achieved with a metal "wave type" diaphragm at the actuating lever providing precision switching unaffected by environmental conditions. They are fully approved under MS 24456-1 (USAF).

The KLIXON KX4 Hermetic Switch is rated for 10 amperes, resistive, at 115 VAC and 30 VDC with life expectancy far in excess of specification requirements. A higher temperature version of the KX4 (KX5) is also available.

Many types of standard actuators are available. Or, to meet the particular requirements of your application, we'll be pleased to design a special package. Write for our precision switch catalog.

KX4 Roller Plunger Actuator

KX5 (High Temperature Version) with Toggle Actuator, above Roller Leaf Actuator, left

METALS & CONTROLS CORPORATION

Spencer Division

2908 Forest Street, Attleboro, Mass.

KLIXON®

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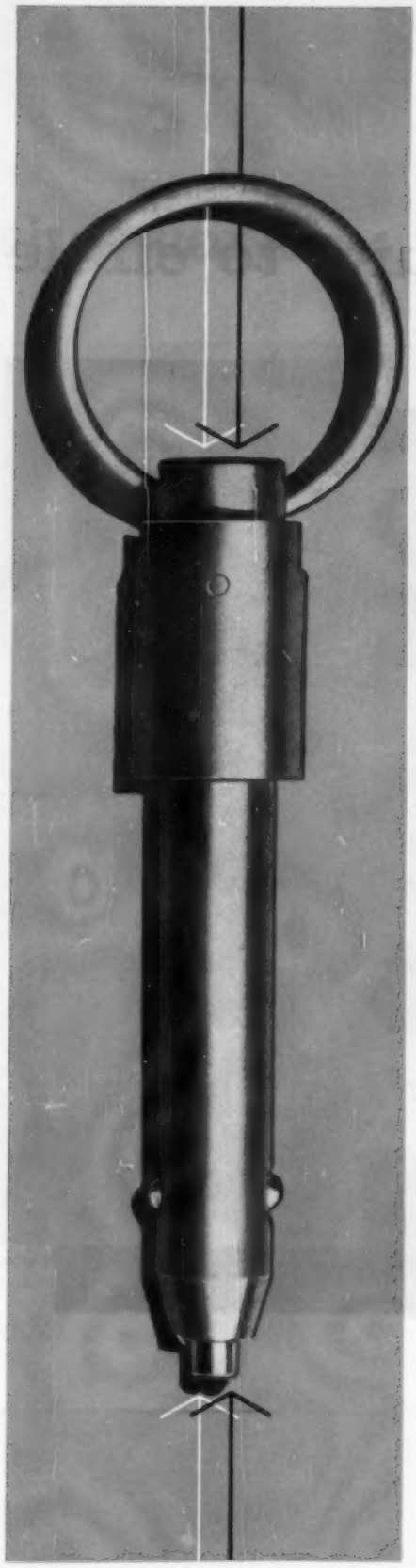


DOUBLE-ACTING "B" SERIES

PIP® SELF-LOCKING QUICK-RELEASE PINS

the pin that's designed for positive release...even under "over-load" or "bound" conditions!

Double-acting PIP Pins combine rugged strength and dependability with INSTANT INSERTION, SELF-SAFETYING... and QUICK RELEASE! Cotter pins, nuts, bolts and other retaining devices are completely eliminated. Result—unlimited design freedom and accessibility where units are frequently assembled and disassembled... permits quick-change of mechanical units... speeds assembly of portable equipment... reduces servicing costs.

Difficult fastening applications where ordinary fastening devices may "bind" in misaligned holes or under unusually heavy loads are "made to order" situations for double-acting "B" Series PIP Pins, which operate on the fast push-to-insert—pull-to-remove principle... but have the added advantage of the exclusive PIP "drive-in"—"drive-out" spindle. It's the safest, most reliable self-locking quick-release pin available!

MEETS RIGID REQUIREMENTS

Double-acting PIP Pins are used by every major aircraft manufacturer and the military services... are specified for use in missiles... used by leading manufacturers of electronics, industrial and materials handling equipment and have proven their complete reliability in many other fields.

Get exclusive PIP Pin "drive-in"—drive-out" advantages in standard diameters to fit most nominal holes. "B" Series PIP Pins with continuous steel ring aid forcible release and adapts to remote release systems.

Use the experience and technical knowledge of our Engineering Staff to determine the right solution to your quick-release fastening problem.

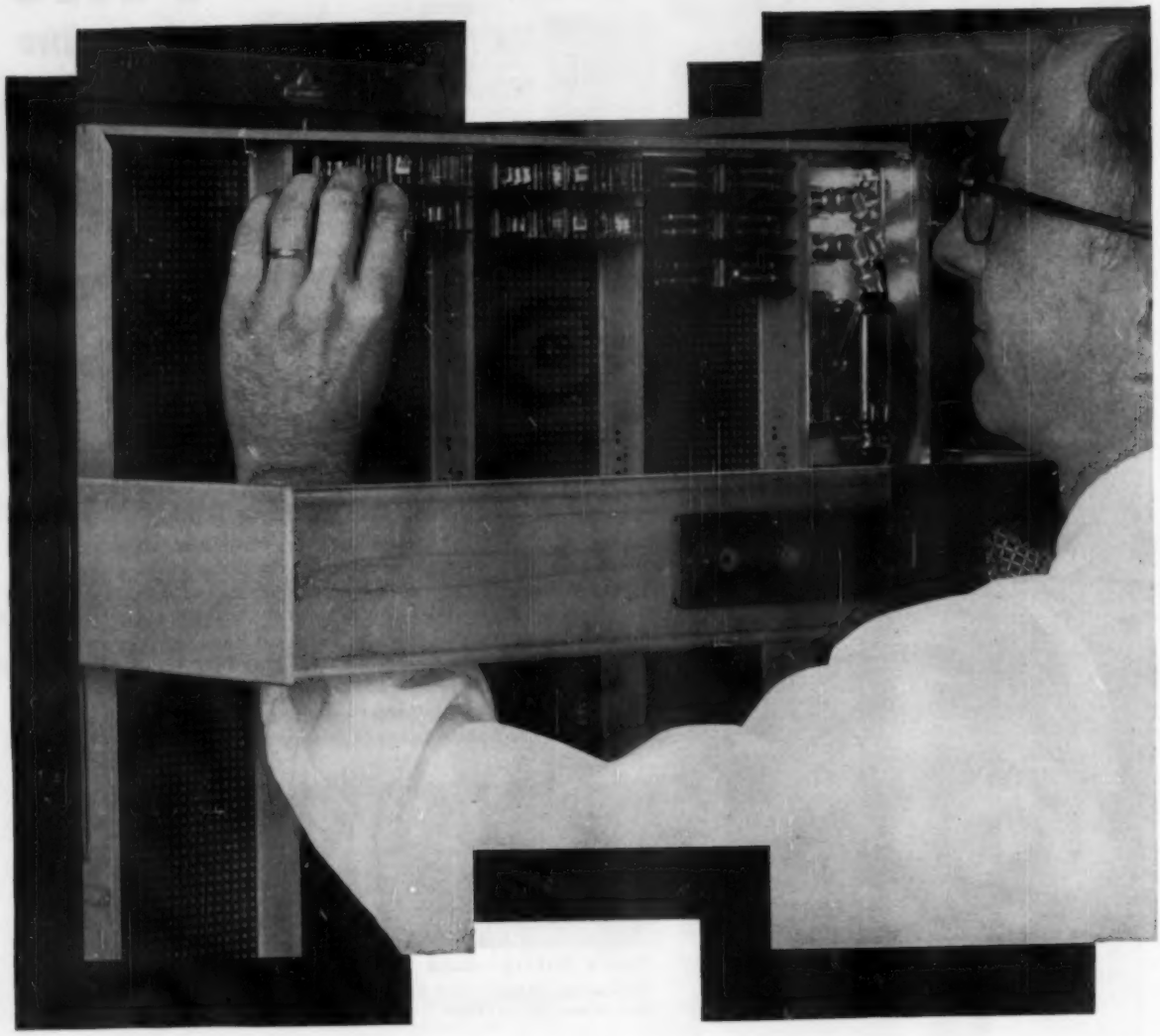
Clevis fitting Tube assembly Bracket assembly

Technical data and specifications are detailed in Brochure No. ADI-5500. Write for your FREE copy today!

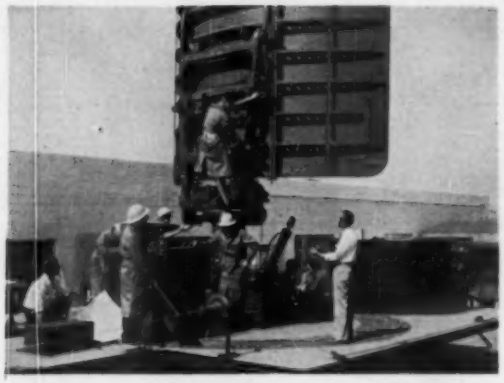
AVIATION DEVELOPMENTS INC.
210 S. VICTORY BLVD.
BURBANK, CALIFORNIA

Sales offices in principal cities
Manufacturers of PIP® Self-Locking Quick-Release Pins, Chobert® Rivets and Avdel Sheet Grippers.

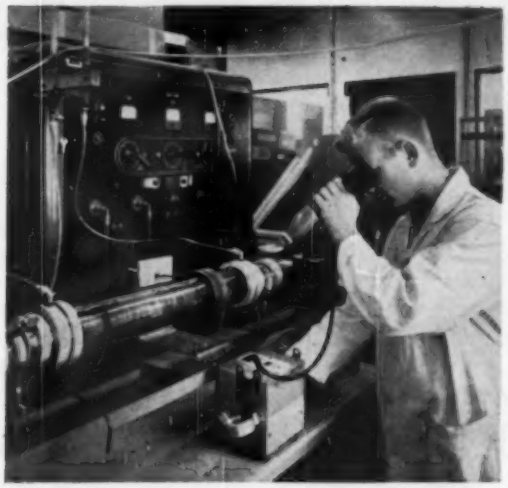
Packing circuits to circle



the world



New Electronic Scanning radar antenna—Frescanar—developed by Hughes at Fullerton, positions beams in space by electronic rather than mechanical means.



Purity Plus—Hughes Products Division engineer checks semiconductor materials to insure purity.

"Project Cordwood" is a new Hughes Communications project which has produced low-cost, widely interchangeable circuit modules *(see photo on left-hand page)*. Other projects under way at the Hughes Communications Division involve the development of systems which deflect their signals from meteors and artificial satellites. Allied to this is the Hughes adoption of the wire-wrapping technique to obtain compact, reliable and automatically applied wiring.

Because of the dynamic growth in communications, Hughes has established a separate, major Communications Division. Already, work has extended past the *transfer* of information to the *use* of information to supplement man's abilities where human resources are inadequate.

From the discovery of basic scientific knowledge through the creation of working hardware, the systems approach is typical of Hughes activities . . . in Airborne Electronics Systems, Space Vehicles, Plastics, Nuclear Electronics, Microwaves, Ballistic Missiles and many others.

This atmosphere offers creative engineers and scientists the widest possible scope of opportunity for personal and professional growth.

Similar opportunities are open at Hughes Products, where Hughes developments are translated into commercial products —semiconductors, specialized electron tubes, and industrial systems and controls.

the West's leader in advanced electronics

HUGHES

HUGHES AIRCRAFT COMPANY, *Culver City, El Segundo, Fullerton and Los Angeles, California; Tucson, Arizona*

I.R.E. CONVENTION: Visit the Hughes Recruiting Center at The Waldorf-Astoria Hotel or Booth Numbers 2801-2807.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Communications	Circuit Design
Semiconductors	Test Engineering
Field Engineering	Systems Analysis
Industrial Dynamics	Technical Writing
Digital Computer Eng.	Electron Tubes
Microwave Engineering	Industrial Systems

Write in confidence, to Mr. Tom Stewart, Hughes General Offices, Bldg. 6-A3, Culver City, California.

© 1959, H.A.C.

MECHANIZATION

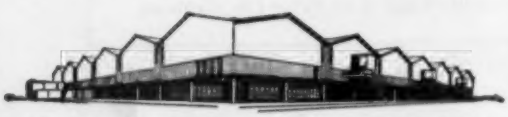
TI-designed fully automatic wafer sorter. Silicon wafers for TI diodes or rectifiers are vibration fed to pick-up stations where they are vacuum gripped by upper contacts of test arms. During transit to drop chutes, lower contacts are applied, polarity checked, test circuits adjusted, and tests performed . . . at a rate of more than 4000 per hour.

Greater reliability, faster delivery and lower unit costs for users of TI diodes and rectifiers result from mechanized production and testing facilities such as the silicon wafer evaluator shown here. Designed and built by the TI Semiconductor-Components division, this machine automatically tests and evaluates each wafer that later becomes the heart of a TI diode or rectifier.

Only advanced facilities can produce advanced components.

The wafer evaluator automatically adjusts its own test conditions to correspond to each wafer being checked, measures the critical electrical parameters, and then guides it into an appropriate vial. These tests, performed before assembly at a rate of more than 4000 per hour, insure the performance of every TI diode and rectifier wafer.

Continuous improvements in production technology at TI provide engineers the world over with precise reliable devices of practical economy and make possible new areas of semiconductor application.



THE WORLD'S LARGEST SEMICONDUCTOR PLANT

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
DALLAS, TEXAS

meeting of minds

to find the means...

Recent contributions of the Aeronautical Division of A. O. Smith include assignments in research and/or production for the Atlas, Polaris, Jupiter, Nike-Zeus and Vanguard projects. A. O. Smith has also helped pioneer heat exchanger design for nuclear seaborne vessels.

A. O. Smith Aeronautical Division continues to demonstrate unique capabilities to work with research and development groups in government agencies and prime and sub contractors in the airframe, propulsion and missile fields.

In three quarters of a century's service to all industries, A. O. Smith has garnered exceptional experience in basic research, welding, metallurgy, heat treating and other areas that delivers a big payload in R&D speed-up as well as establishing sound production procedures.

A. O. Smith facilities and experience are available to any accredited member of the aviation-missile-rocket industry. For more details, call or write —

Through research . . . a better way

A.O.Smith

CORPORATION

AERONAUTICAL DIVISION

Milwaukee 1, Wisconsin

FIRST LOW-COST SPACE AGE AIRCRAFT DEMONSTRATES NORAIR SYSTEMS MANAGEMENT CAPABILITY

The twin-jet T-38 –America's first supersonic trainer–aptly demonstrates Norair's capability in systems management. Now in production under USAF contract, the T-38 Talon is the first member of a Northrop-conceived family of lightweight, low-cost space age aircraft.

Soon to follow: a supersonic counterair fighter, the N-156F – first weapon system designed in America for the specific tactical and economic requirements of those free allied nations most vulnerable to enemy attack.

Other important systems management achievements include the USAF Snark SM-62A and the F-89 Scorpion. Norair management of the Snark program produced the free world's first operational intercontinental guided missile – delivered on time and at minimum cost.

In producing America's first nuclear-armed interceptor, Norair's weapon system management of the F-89 was marked by on-time delivery of more than 1,000 units throughout the program's life, and by a significant dollar underrun. A full ten years after its first flight, the Scorpion is still the USAF's most heavily armed interceptor – and a uniquely stable platform for air-launch of atomic rockets.

Norair's cost-proved record of effective management, integrated facilities, and available resources combine to demonstrate outstanding capability as a prime systems contractor.

NORAIR *formerly Northrop Division*
HAWTHORNE, CALIFORNIA
A DIVISION OF NORTHROP CORPORATION

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NEW LOX TANKING COMPUTER SYSTEM

WITH 1/10% OVERALL ACCURACY

NOW IN PRODUCTION
BY LEONARD FOR THE
ARMY BALLISTIC
MISSILE AGENCY

OTHER RECENT CONTROL PROJECTS BY LEONARD INCLUDE:

- PROPELLANT UTILIZATION COMPUTER
- TANKING COMPUTER CALIBRATOR
- LOX TANK LEVEL TRANSDUCER
- MACH NUMBER DEVIATION COMPUTER
- INDICATED AIR SPEED TRANSDUCER
- DRAG-RISE DETERMINATION SYSTEM
- INDICATED ALTITUDE TRANSDUCER
- PRESSURE RATIO COMPUTER

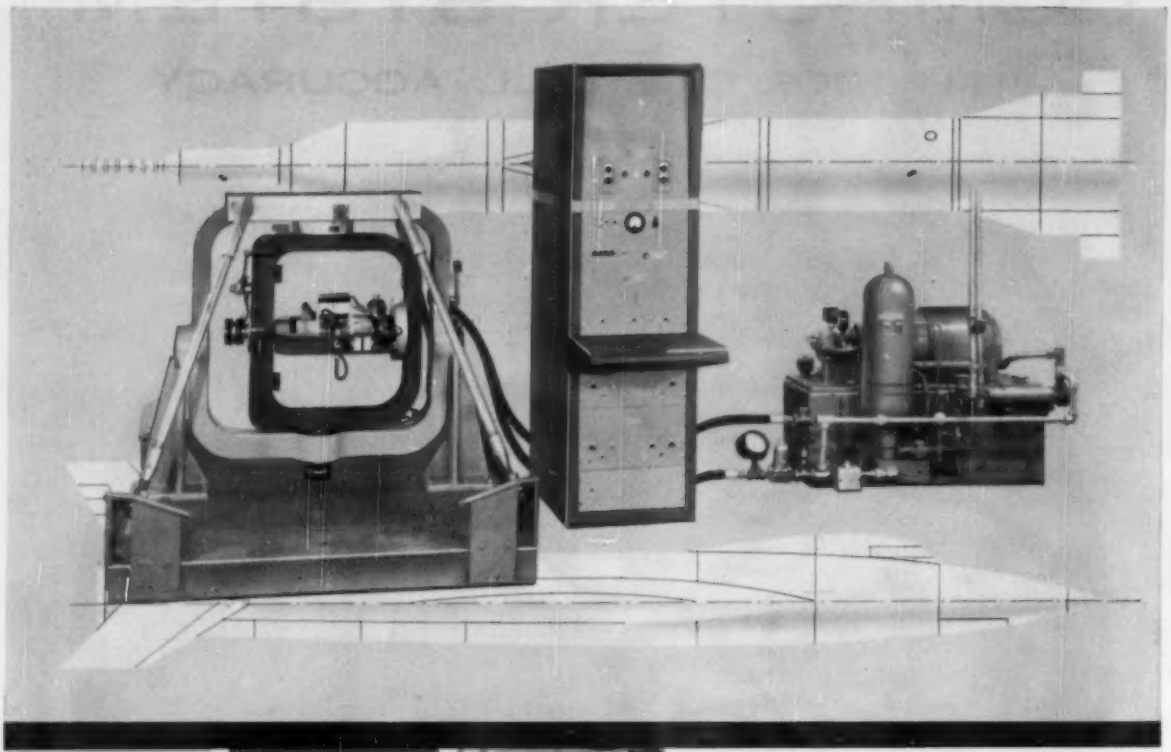
Please discuss your system requirements with our engineers.

LEONARD PASADENA

Wallace O. Leonard, Inc.
373 SOUTH FAIR OAKS AVENUE
PASADENA, CALIFORNIA
TELEPHONE SYCAMORE 2-7131
TWX-PASA CAL 7321

THREE-AXIS FLIGHT SIMULATION

assures sytem accuracy and stability



Direct hydraulic drive, free from gear noise, produces exceedingly smooth motion from rates as low as the earth's rotation to velocities and accelerations considerably higher than those encountered in modern, high-performance aircraft and missiles.

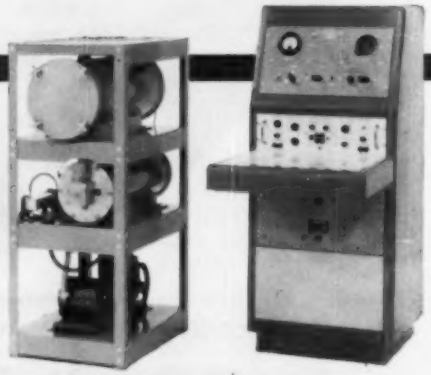
By creating the same dynamic motions met in high-performance aircraft and missiles, the CTI Three-Axis Flight Simulator enables accurate analyses of flight control systems and inertial guidance platforms to be made in the laboratory.

Any conventional analog computer can be used with the Flight Simulator for combined programming and system analysis. Computer (or other signal source) voltages representing a pre-determined flight path are accurately translated into roll, pitch, and yaw positions, velocities, and accelerations by means of a position-feedback servo system. Superior performance with large-volume, high-inertia loads is achieved at minimum cost and maintenance by the unusual simplicity of design.

Only the use of actual control components under identical flight-motion conditions can enable a laboratory evaluation to assure flight performance. Write for complete technical specifications.

DYNAMIC ALTITUDE SIMULATOR

Available separately or as a companion unit to the Three-Axis Flight Simulator, this Altitude Simulator reproduces dynamic altitude changes through a bandwidth of ±700 feet with a frequency response of 10 cps. Operating range is sea level to 80,000 feet.



Engineers: Career opportunities are currently available at CTI.

CTI®

CALIFORNIA TECHNICAL INDUSTRIES
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Foremost in Automatic Testing

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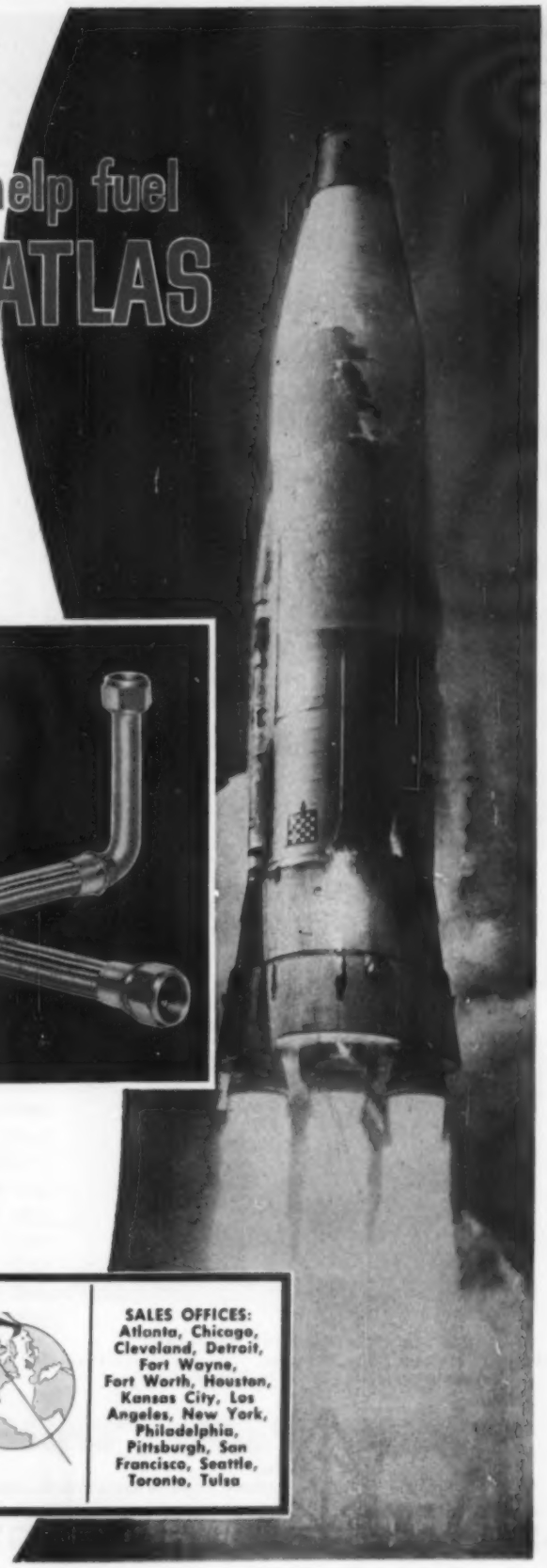
Stratoflex assemblies help fuel
THE MIGHTY ATLAS



Every time a Convair Atlas intercontinental ballistic missile lifts from its Cape Canaveral launching pad, fantastic demands are made of the fueling system and powerplant.

A touch of the blast-off button triggers hundreds of simultaneous chain reactions in the giant ICBM's fuel system. Under tremendous pressure, liquid oxygen is delicately and precisely force-mixed with a kerosene-like fuel and flashes through the lines as vapor to feed the fires burning in the combustion chamber. This blend, mix, fire sequence must commence in a split second and continue at tremendous speed if the launch is to be successful. Fuel line plumbing on the Atlas must be absolutely leakproof, immune to strong vibrations, and able to withstand continuous temperature variations.

Despite the infinite possibilities for human mistake and material malfunction, the Air Force, aided by Convair technicians, has successfully launched the Atlas ICBM time after time at Cape Canaveral. (In the spectacular December 18, 1958 firing, the 85-foot Atlas was placed in orbit around the earth.) Stratoflex is proud that its specially-designed Teflon* hose and metal tubing assemblies are vital parts of the Atlas fuel line system.

* A DuPont trademark

STRATOFLEX Inc.

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Branch Plants: Los Angeles, Fort Wayne, Toronto
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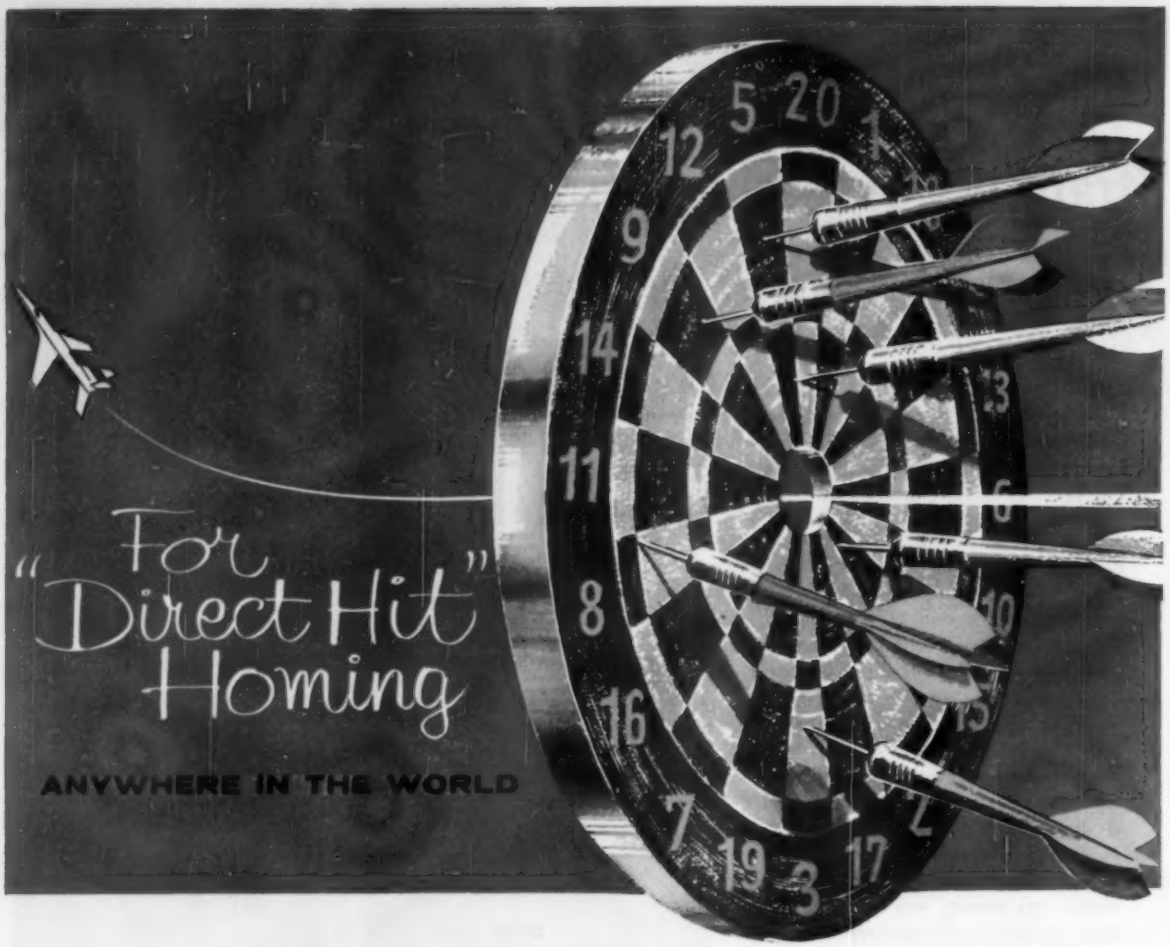
SF1-9



ARC'S TYPE 21A AUTOMATIC DIRECTION FINDER

TYPE 21A ADF WEIGHS ONLY 19.7 POUNDS
Component Unit Weights: Receiver, 6.8 lbs.; Loop, 4.3 lbs.; Loop Housing, 0.5 lbs.; Indicator, 1.3 lbs.; Control Unit, 1.6 lbs.; Power Unit, 5.2 lbs.;

As every pilot knows, a reliable ADF is still a basic and useful navigation aid. Throughout the world there are some 60,000 transmitters that offer pin-point guidance, over land and sea.

ARC's Type 21A ADF can be depended upon for precision homing under long-continued use in humid tropics, frigid northlands or burning deserts. It is one of ARC's outstanding contributions to air navigation. Its low weight (less than 20 pounds) and compactness make dual installations practicable even in light twins. If you plan to modernize existing equipment or are purchasing a new aircraft, specify the Type 21A for a long term investment in air safety.

Ask your ARC dealer for a quotation on this and any of the other ARC equipment listed below.

CAA Certificate No. 1R4-9 U.S. Military: AN/ARN-59 British Certificate of Approval VC-78

Aircraft Radio Corporation BOONTON, N. J.

Dependable Airborne Electronic Equipment Since 1928

OMNI/LOC RECEIVERS • MINIATURIZED AUTOMATIC DIRECTION FINDERS • COURSE DIRECTORS • LF RECEIVERS AND LOOP DIRECTION FINDERS
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30 YEARS OF ACHIEVEMENT IN AIRBORNE ELECTRONICS 1928 ARC 1958

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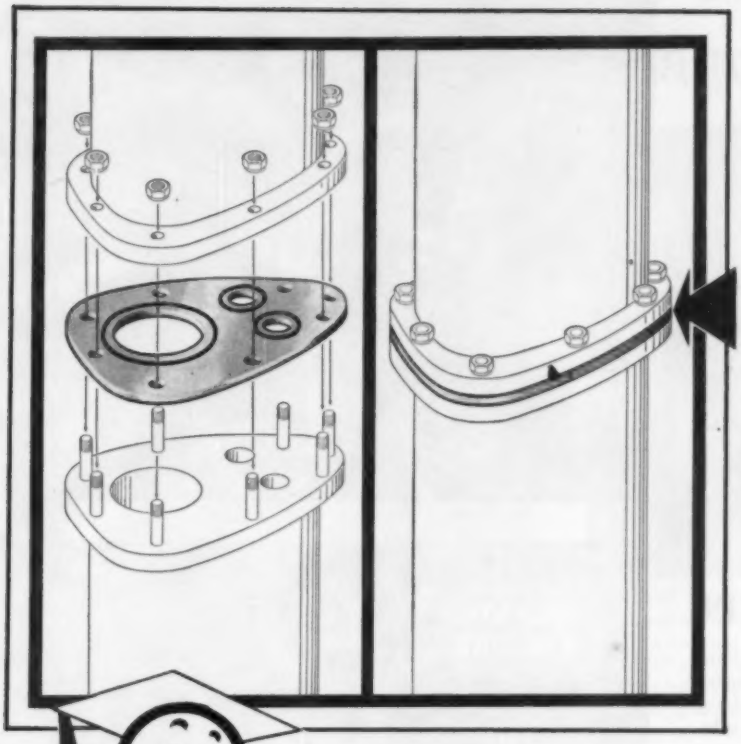
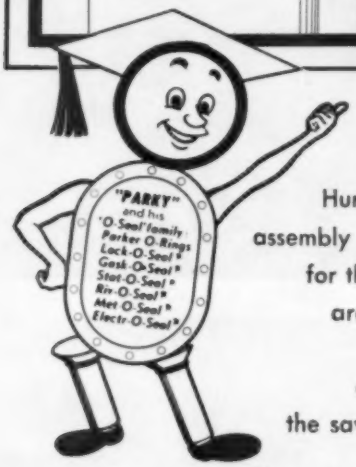
DO YOU KNOW ABOUT GASK-O-SEALS?

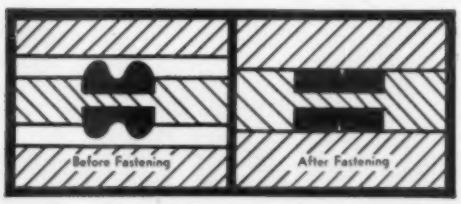


You Can't leave a Gask-O-Seal® out!



Hundreds of accidents have been caused by seals being left out during assembly or repair, and thousands of production hours have also been lost for the same reason. Just one of the plus values of Gask-O-Seals is that they are practically impossible to leave out because they are inspectable visually after assembly. This can mean many valuable warranty dollars saved, many hours of downtime saved — and it may mean the saving of human lives.

They also provide no-leakage positive sealing, prevent blow-outs. Damaging coldflow is eliminated, high manufacturing and maintenance machining costs are avoided and they are reuseable. If you use static seals in your designs, why not find out about Gask-O-Seals — made by the makers of Parker O-rings.



Parker SEAL COMPANY
CULVER CITY, CALIFORNIA and CLEVELAND, OHIO
A DIVISION OF PARKER-HANNIFIN CORPORATION

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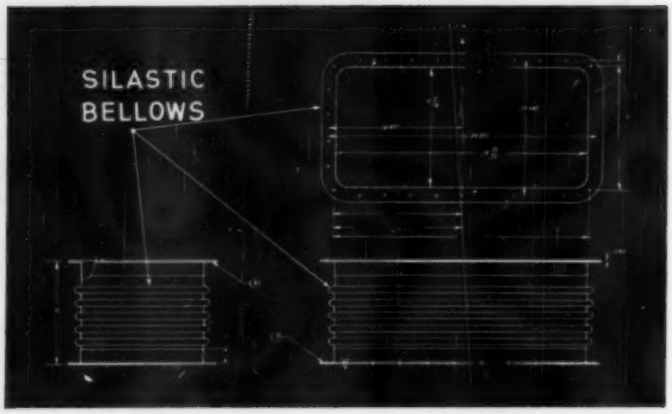
Circle Number 32 on Reader-Service Card→

The PLANE

Douglas' C-133A, powerful long-range transport on duty with the USAF. Designed primarily as a logistics airplane, the C-133A can also be modified to carry over 200 fully armed troops. Power: four Pratt & Whitney T34 turboprop engines. Range: over 4,000 miles with 40,000 pounds or 1,600 miles with 94,000 pounds.

The PROBLEM

Developing heating system ducts that would not be damaged by vibration. Originating under the turboprop cowls, the ducts must withstand not only vibration but heat as well. A rubber bellows would solve the shock absorbing problem . . . but ordinary rubber can't take the high temperature.



The PRODUCT

SILASTIC
SILICONE RUBBER

Douglas engineers chose a bellows of Silastic®, the Dow Corning silicone rubber. Silastic resists the heat involved, does not crack or embrittle with age.

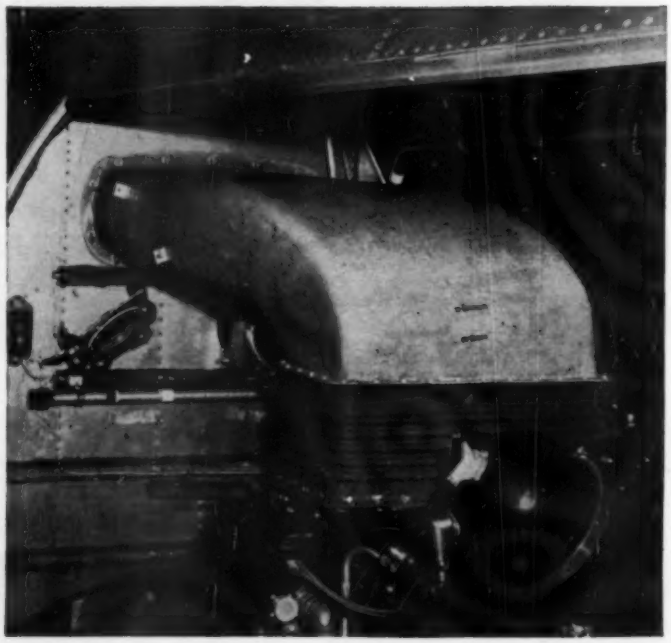
TYPICAL PROPERTIES OF SILASTIC FOR DUCTS

Temperature range, °F	—130 to 500
Tear Strength, lb/in	40 to 200
Ozone resistance	excellent
Pressure range	low pressure

For further information write Dept. 0915.

first in silicones

Dow Corning
CORPORATION
MIDLAND, MICHIGAN



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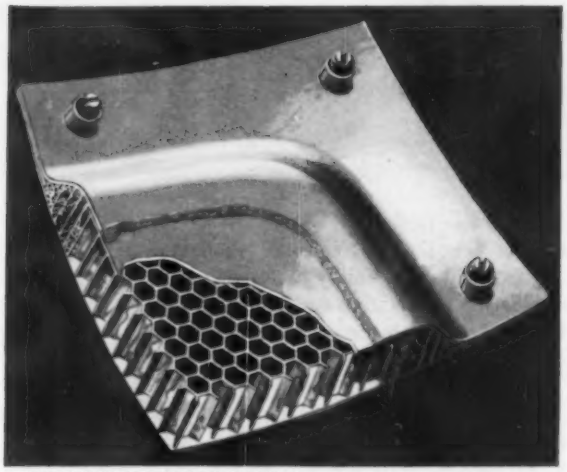
Brunswick technology leads the way in three critical space-age components

PRESSURE VESSELS AND MOTOR CASES, fabricated by Brunswick's exclusive Strickland "B" Process, now have the highest strength-to-weight ratio ever obtained in filament-wound components. Brunswick is *now* producing these virtually leak-proof pressure vessels. Brunswick also fabricates motor cases capable of withstanding extremely high pressures and temperatures.

RADOMES AND NOSE CONES, created by Brunswick's outstanding research and development efforts and filament winding process, are being used on supersonic aircraft such as the advanced Convair F-106 and McDonnell F4H, as well as on missiles such as the Boeing Bomarc, Lockheed Q5 and similar missiles. And, of course, Brunswick capabilities include complete electronic design and test facilities.



HONEYCOMB ASSEMBLIES, now developed by Brunswick can support two million times their own weight. Brunswick research has created honeycomb assemblies of paper, fiber glass, aluminum and stainless steel as well as conventional forms. Using the most advanced adhesive systems, these assemblies can be formed in compound curvatures with extremely close tolerances.

RESEARCH, DEVELOPMENT AND TESTING—carried on by Brunswick teams have contributed heavily to space-age technology . . . most notably in solving problems of increasingly high operating temperatures (600°–4,000°F.) for critical components and new heights in strength-to-weight ratios. For full information on how this leadership can help you, write or call Brunswick today!

BRUNSWICK

DEFENSE PRODUCTS DIVISION • 1700 MESSLER STREET • MUSKEGON, MICHIGAN

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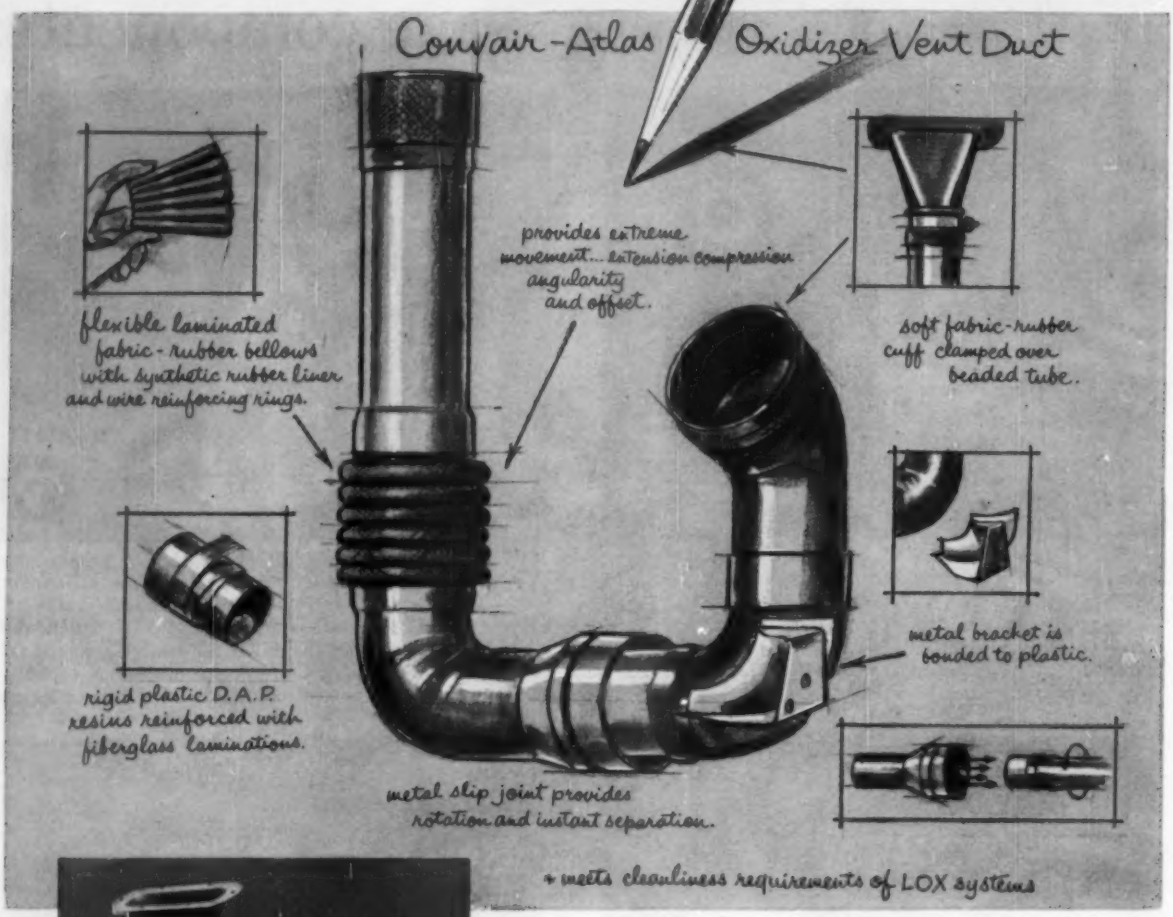
Design Notes on Ducting by Arrowhead


Convair-Atlas Oxidizer Vent Duct
provides extreme movement... extension compression angularity and offset.
flexible laminated fabric-rubber bellows with synthetic rubber liner and wire reinforcing rings.
soft fabric-rubber cuff clamped over beaded tube.
metal bracket is bonded to plastic.
rigid plastic D.A.P. resins reinforced with fiberglass laminations.
metal slip joint provides rotation and instant separation.
+ meets cleanliness requirements of LOX systems

This complex rigid flexible Oxidizer Vent Duct is supplied to Convair (Astronautics) Division of General Dynamics Corp.

This Oxidizer Vent Duct serves as an excellent example of Arrowhead's engineering ability to design and produce in a combination of materials (metal, plastic and fabric-rubber) integral "no leak" units having abilities and features which could not be duplicated in any one or two of these materials.

The requirements of this application were for a flexible, lightweight duct assembly which would permit angularity, offset and rotational movements . . . withstand moderate temperatures...and provide a "leak free" slip joint allowing separation at 10 fps. speed.

For engineering consultation on such complex ducting problems contact Arrowhead's Field Service Representative in your area or write direct to the factory.

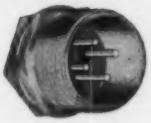
Arrowhead
PRODUCTS
2300 Curry Street, Long Beach, California
Division of Federal-Mogul-Bower Bearings, Inc.

Circle Number 35 on Reader-Service Card

Wherever instruments are used within a partial vacuum, inert gas, or a constant or controlled pressure, use . . .

Canseals

GS



MS type. Available in many layout arrangements

HERMETICALLY SEALED CANNON PLUGS

Otto von Guericke's famous experiment with his vacuum or "Magdeburg Hemispheres" which required 16 horses to pull apart during such tests in 1650.

KH

General industrial type features Acme thread

DH

Hermetically-sealed sub-miniatures

DPSH

Designed for high altitude and vibration applications

Rugged protection and true hermetic sealing under adverse pressure and atmospheric changes.

Cannon pioneered the first successful hermetically sealed connector more than nine years ago . . . and since then has continually refined and expanded the line. All have special steel contacts and steel shells. Glass insulation . . . **fused to both contacts and shell for a permanent seal** . . . permits the use of **highest conductive steel contacts** compatible with any glass fusing operation. Cannon glass insulated connectors will successfully withstand continuous operating temperatures up to 500°. And for short periods of operating time they will withstand much higher temperatures.

Cannon hermetically sealed connectors are manufactured to our own commercial specifications. In general, however, voltage ratings approximate Service A of Specification MIL-C-5015C. **Salt spray, shock,** and **vibration** characteristics are all approximately within the requirements of MIL-C-5015C. Mating requirements meet MIL-C-5015C exactly. These connectors have consistently been contractually approved for military installations.

Hermetically-sealed Series available include: GS (MS type), KH, RKH, KH miniature, BFH, DH, MCH, DPAH, DPSH and DPXH.

For an interesting discussion of the broad subject of "Reliability," write for Cannon Bulletin R-1.

Write for 44-page, 2-color Plug Guide, Bulletin CPG-3

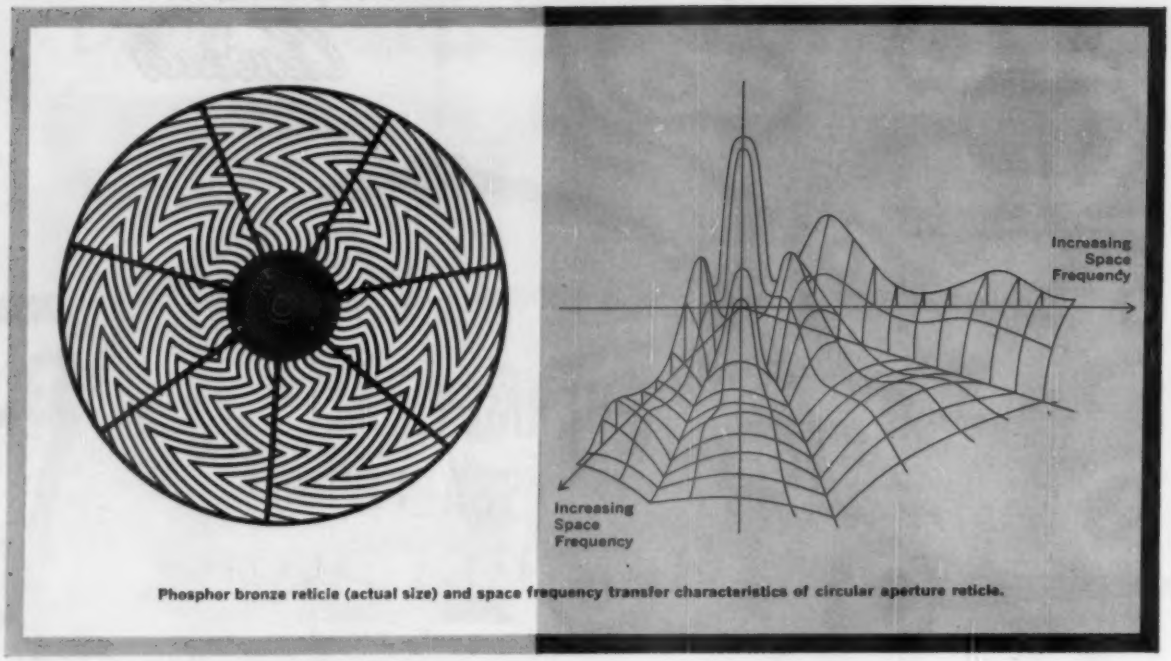
Please refer to Dept. 110

CANNON PLUGS

WHERE RELIABILITY IS THE 5TH DIMENSION

CANNON ELECTRIC CO., 3208 Humboldt Street, Los Angeles 31, California • Factories in Los Angeles, Salem, Massachusetts, Toronto, Melbourne, London. Manufacturing licensees in Paris and Tokyo. Representatives and distributors in all principal cities. See your Telephone Yellow Book.

Circle Number 36 on Reader-Service Card



Phosphor bronze reticle (actual size) and space frequency transfer characteristics of circular aperture reticle.

TARGET DISCRIMINATION IN INFRARED DETECTION SYSTEMS

The pioneering field of infrared detection offers many challenging opportunities to scientists and engineers at Ramo-Wooldridge for advanced studies in the solution of target discrimination problems. Research is continually under way at Ramo-Wooldridge in the integrating of infrared detection devices with the latest electronic systems techniques for enhanced target detection on the ground and in the air.

The phosphor bronze reticle, or image chopper, illustrated above was developed by Ramo-Wooldridge. It indicates a marked stride in space filtering discrimination concepts, and is used for target signal enhancement in guided missiles, anti-aircraft fire control and air collision warning applications.

The reticle is used in the focal plane of an infrared optical system and is rotated to chop the target image for the desired space filtering. It is also employed in time filtering, such as pulse length discrimination, or pulse bandwidth filtering.

Space filtering is critical to infrared systems, because of its ability to improve the detection of objects located in the midst of background interference. In a manner similar to that used in the modification of electronic waveforms by electrical filtering, space filtering enhances the two-dimensional space characteristics of a target. The size and features of the target are highlighted and the undesired background eliminated.

Scientists and engineers with backgrounds in infrared systems—or any of the other important areas of research and development listed below—are invited to inquire about current opportunities at Ramo-Wooldridge.

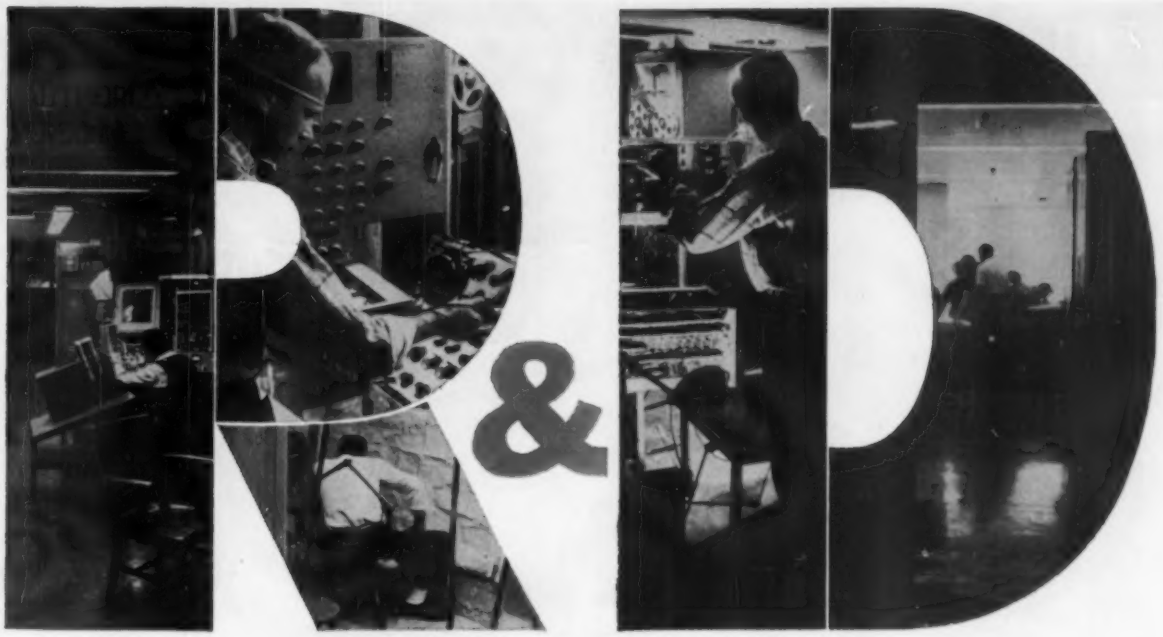
- Electronic reconnaissance and countermeasures systems
- Analog and digital computers
- Air navigation and traffic control
- Antisubmarine warfare
- Basic research
- Electronic language translation
- Information processing systems
- Advanced radio and wireline communications
- Missile electronics systems

RAMO-WOOLDRIDGE

P.O. BOX 90534 AIRPORT STATION • LOS ANGELES 45, CALIFORNIA

a division of *Thompson Ramo Wooldridge Inc.*

Circle Number 37 on Reader-Service Card



advanced R & D capability now available at CEC's Datalab

Research and development programs under contract to progressive firms are a specialty at Datalab... CEC's Advanced Electronic Data Laboratory. Recently completed at Datalab was a revolutionary new concept in airborne test instrumentation, developed for a leading airframe manufacturer. Now available are pulse code modulation telemetry systems, special magnetic tape transports, such as high-density digital recording, and transistorized data handling equipment... emphasizing solid state and miniaturization techniques. Datalab engineers can undertake additional projects in the field of data handling and storage, including those concerned with the conversion, transmission, and enciphering of digital data, as well as system and design studies.

Datalab specialists are available for informative discussions of general or specific data handling problems. Contact your nearest CEC office or write for Bulletin CEC 1314-X2.

Datalab Division CEC

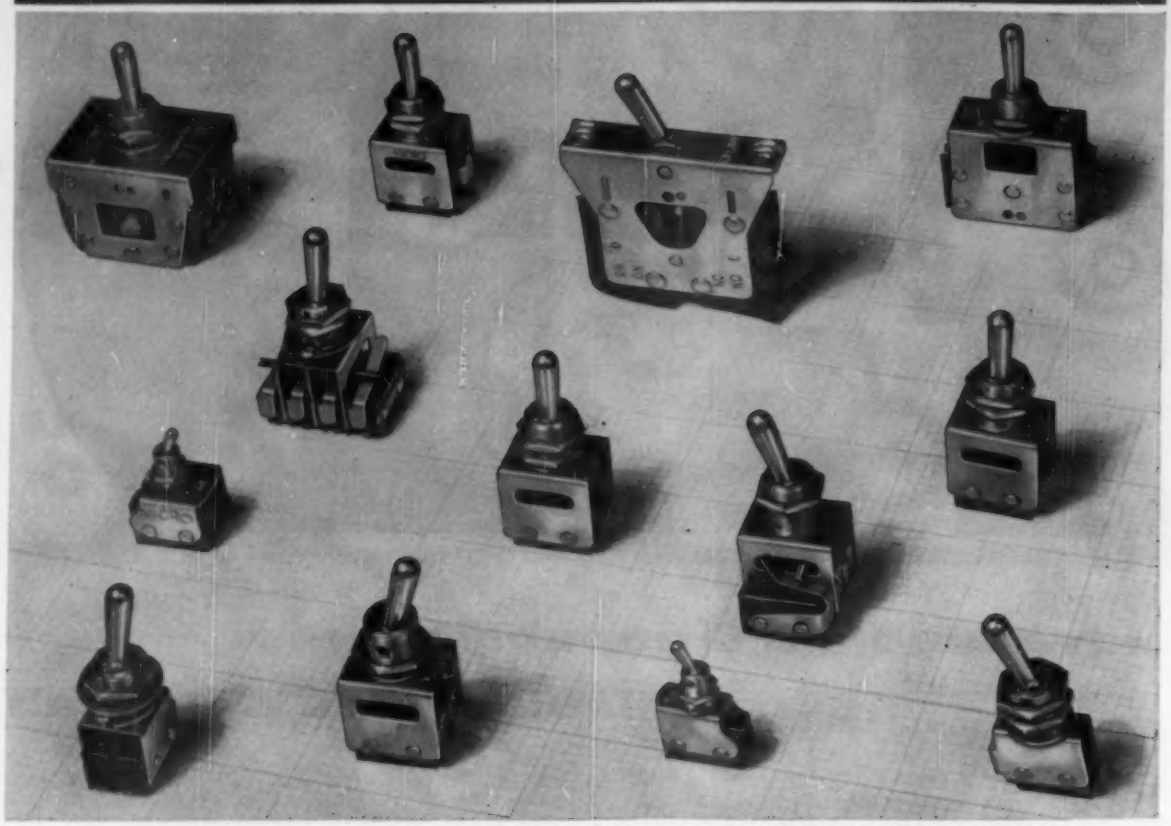
CONSOLIDATED ELECTRODYNAMICS *300 N. Sierra Madre Villa, Pasadena, Calif.*

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

Datalab has openings for qualified engineers who wish to join the company's team of experienced R & D specialists and participate in work of an advanced and interesting nature. Immediate needs exist for mechanical engineers and transistor circuit engineers, as well as technical writers.

Circle Number 38 on Reader-Service Card

MICRO SWITCH Precision Switches



Compact "AT" toggle switch assemblies meet wide range of requirements in small space

The 13 toggle switch assemblies illustrated above represent a group of more than 100 similar compact assemblies designed to actuate from one to as many as a dozen miniature precision basic switching units. They find wide use in aircraft, mobile, marine, electronic, and all panel applications.

In this group are 2- and 3-position switches, in all combinations of contact arrangements . . . with either maintained or momentary lever positions. Within the group are switches for special requirements. For example, the switch at upper right includes an "electric memory" unit that indicates by a light or buzzer which circuit was last actuated. Other assemblies in the line feature pull-to-unlock levers, sealed levers, and hermetically-sealed basic switches.

All are manufactured with utmost precision, with consideration given to such important details as rigidity, positive "feel" and positive action, ease of mounting, good appearance, and long life.

"AT" toggle switch assemblies are described fully in Catalog 73. Assistance in switch application is available from the MICRO SWITCH Branch Office near you.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH PRECISION SWITCHES

Circle Number 39 on Reader-Service Card

An orientation to home?

Domain orientation?

The secret of a lodestone?

The cosmic ray accelerator?

An aspect of a unified field?

Fundamental to Allison's business—energy conversion—is a complete familiarity with magnetism in all its forms. This knowledge is essential to our conversion work.

Thus we search for a usable definition of magnetism—not only what it is, but why it is. And to aid us in our search, we call upon the capabilities within General Motors Corporation and its Divisions, as well as the specialized talents of other organizations and individuals. By applying this systems engineering concept to new research projects, we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

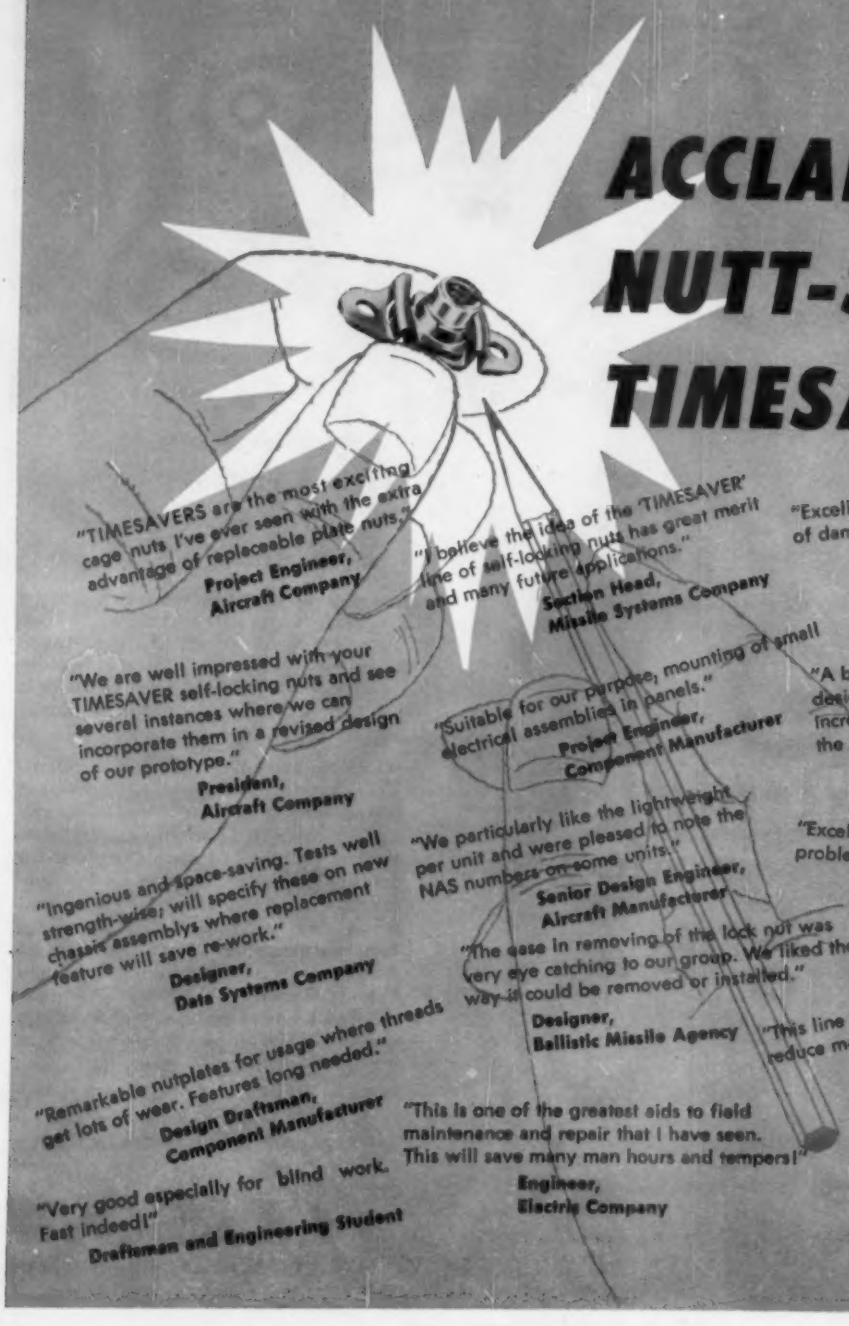
Energy conversion is our business

ALLISON

Division of General Motors,
Indianapolis, Indiana

ENGINEERS

ACCLAIM NUTT-SHEL'S TIMESAVERS...



"TIMESAVERS are the most exciting cage nuts I've ever seen with the extra advantage of replaceable plate nuts."
Project Engineer, Aircraft Company

"I believe the idea of the 'TIMESAVER' line of self-locking nuts has great merit and many future applications."
Section Head, Missile Systems Company

"Excellent idea for field replacement of damaged nuts."
Supervisor, Component Manufacturer

"We are well impressed with your TIMESAVER self-locking nuts and see several instances where we can incorporate them in a revised design of our prototype."
President, Aircraft Company

"Suitable for our purpose, mounting of small electrical assemblies in panels."
Project Engineer, Component Manufacturer

"A big improvement over existing designs. Serviceability will be greatly increased in certain applications by the use of 'TIMESAVERS'."
Lead Instructor, Aircraft Company

"Ingenious and space-saving. Tests well strength-wise; will specify these on new chassis assemblys where replacement feature will save re-work."
Designer, Data Systems Company

"We particularly like the lightweight per unit and were pleased to note the NAS numbers on some units."
Senior Design Engineer, Aircraft Manufacturer

"Excellent. Eliminated one of the worst problems in using captured nuts."
Engineer, Component Manufacturer

"The ease in removing of the lock nut was very eye catching to our group. We liked the way it could be removed or installed."
Designer, Ballistic Missile Agency

"Remarkable nutplates for usage where threads get lots of wear. Features long needed."
Design Draftsman, Component Manufacturer

"This line of self-locking nuts should greatly reduce maintenance time; very good idea."
Engineer, Aircraft Company

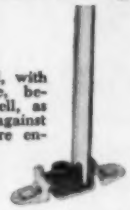
"Very good especially for blind work. Fast indeed!"
Draftsman and Engineering Student

"This is one of the greatest aids to field maintenance and repair that I have seen. This will save many man hours and tempers!"
Engineer, Electric Company

in 5 SECONDS

you can replace the nut in a **TIMESAVER**

1. Insert removal tool, with downward pressure, between nut and shell, as shown. Lean tool against nut barrel to insure engagement.



2. Maintain downward pressure. Nut will snap out easily with a simple prying motion.

3. Install new nut by inserting one lug in shell and striking opposite lug with screwdriver. This lug snaps into place.

the greatest advancement to date, in efficient fasteners!

Consensus of opinion among engineers who tested TIMESAVERS is this: a definite improvement in nut design that saves time and reduces costs.

In comparing them with conventional plate nuts, they asked these questions: *Are they lightweight?* Yes. They are as light as conventional nuts and in certain designs, they are lighter. *Are they more costly?* No. They are priced the same as conventional nuts. Actually, they cost less, since savings in replacement time are greater than the cost of conventional nuts including installation. *Are they preferable for all applications?* The cost of damaged nuts may be a secondary consideration. The important fact is that TIMESAVERS provide the replaceable threaded element at no extra cost and TIMESAVERS are suitable for 85% of the applications where conventional nuts are used. *Are they approved?* Yes. They meet MIL-N-25027 (ASG) and conform to NAS specifications. *Are there advantages, other than the quick replacement feature?* Yes. For example, masking, to eliminate paint contamination of threaded element, is unnecessary when TIMESAVERS are used. Retainers can be installed before painting and nuts snapped in later.

Tell Us Your Fastening Problems

Nutt-Shel engineers approach fastening problems from two viewpoints: 1.) that of the engineer, and 2.) that of the production men and women who work with engineers' creations. These two groups aided us in being first with narrow, floating nuts, self-sealing dome nuts and NAS miniatures. If your fastening problem calls for something special, write today.

Nutt-Shel

An **sps** Company

2701 SO. HARBOR BOULEVARD

SANTA ANA, CALIFORNIA

Telephone Kimberley 5-9311

Circle Number 40 on Reader-Service Card

Lockheed's turboprop Electra:

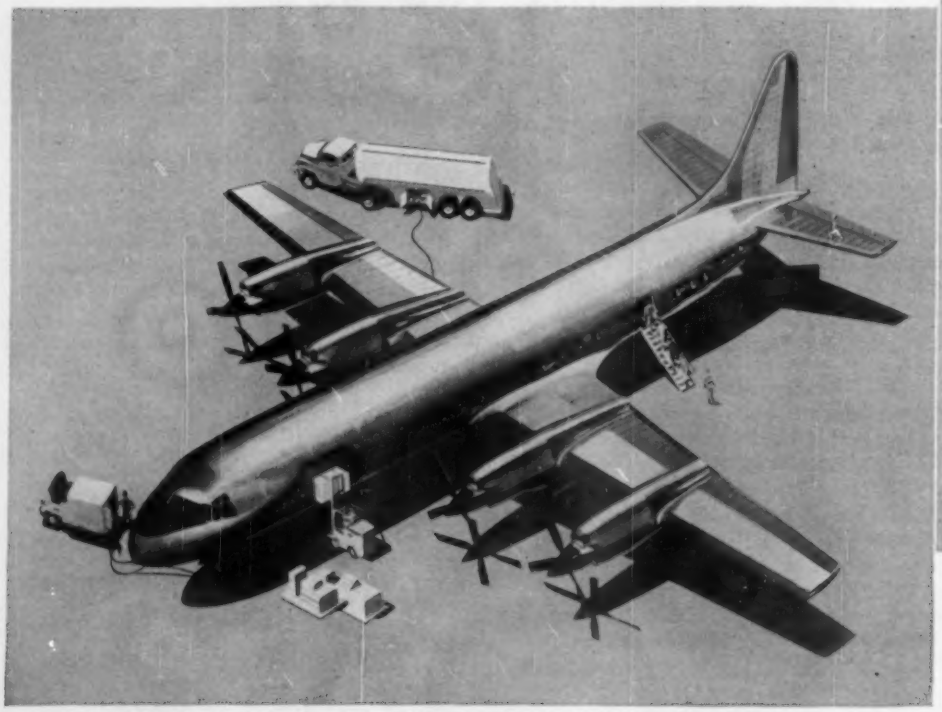
Performance-proved for 8 key military missions

During its recent headline-making 52,000-mile tour—of the United States, Canada, Europe, Asia, and the Middle East—Lockheed's new turboprop ELECTRA airliner dramatically demonstrated its amazing performance capabilities.

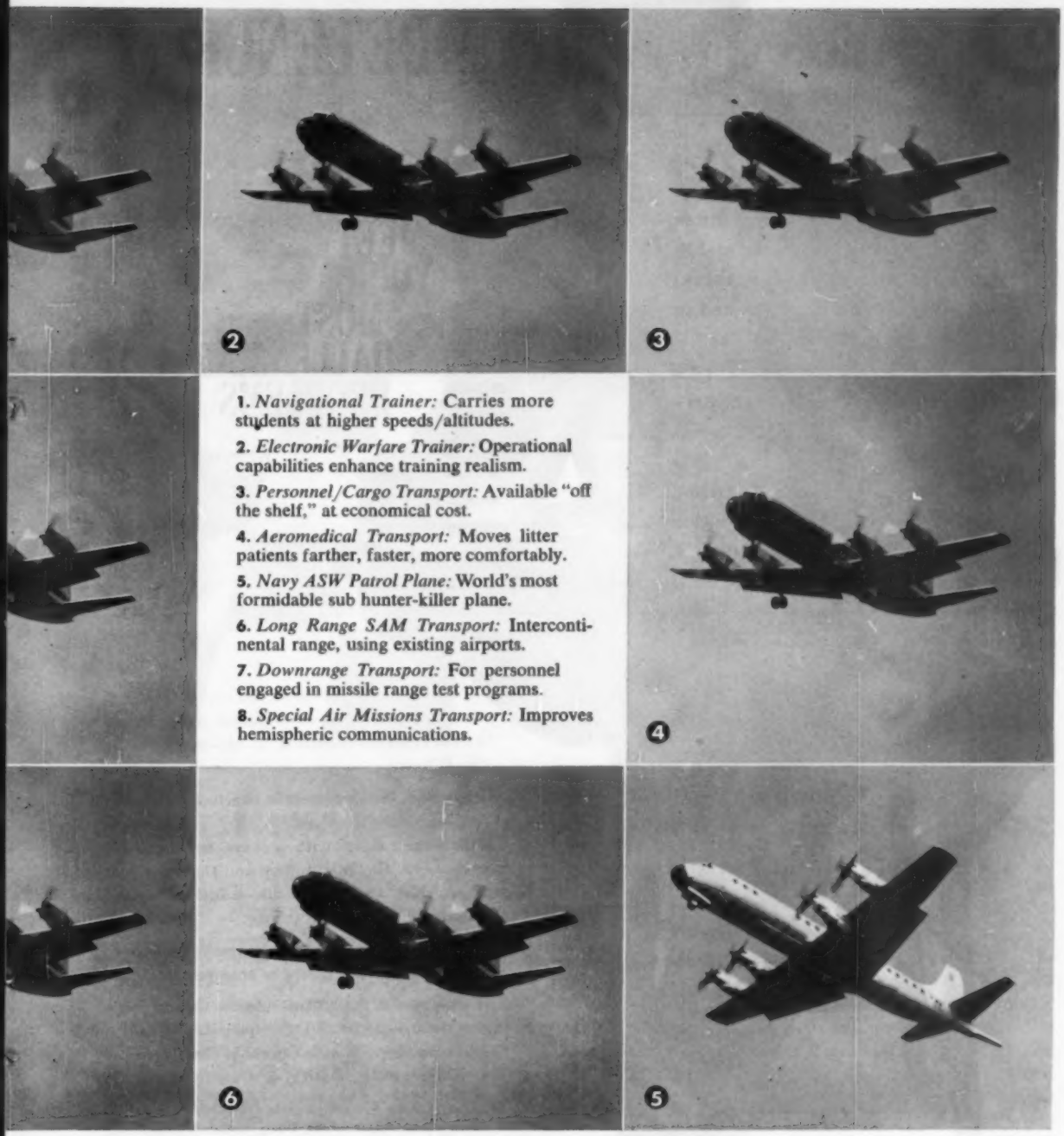
Seasoned pilots were astonished by the ELECTRA's short takeoffs and landings—especially its safe, sure stops on rain-slick runways. Over the Alps, with two engines purposely cut and one prop at zero thrust, the ELECTRA cruised on only *one* engine. Taking off at 115,000 pounds gross weight, the ELECTRA flew non-stop 3220 miles from Istanbul, Turkey to New Delhi, India —in a record breaking 7 hours, 55 minutes.

The ELECTRA's proven performance, safety, ease of maintenance, and economy of operation qualify it in every essential to fill the Armed Forces' requirements for eight new Jet Age aircraft, each performing a different key mission.

Because ELECTRA airliners will be in service for airlines throughout the world, emergency service and parts for military ELECTRAS will be readily available worldwide. Result: optimum global utilization of USAF and Navy ELECTRAS—at minimum costs for parts inventories and service.



Completely self-sufficient, the ELECTRA can land at out-of-the-way airports and remote landing strips—because it has its own engine starters and ground air-conditioning, plus built-in passenger stairs. Passenger/cargo loading, refueling, and servicing of the ELECTRA can all be done simultaneously.



1. *Navigational Trainer:* Carries more students at higher speeds/altitudes.
2. *Electronic Warfare Trainer:* Operational capabilities enhance training realism.
3. *Personnel/Cargo Transport:* Available "off the shelf," at economical cost.
4. *Aeromedical Transport:* Moves litter patients farther, faster, more comfortably.
5. *Navy ASW Patrol Plane:* World's most formidable sub hunter-killer plane.
6. *Long Range SAM Transport:* Intercontinental range, using existing airports.
7. *Downrange Transport:* For personnel engaged in missile range test programs.
8. *Special Air Missions Transport:* Improves hemispheric communications.

LOCKHEED

LOCKHEED AIRCRAFT CORPORATION, CALIFORNIA DIVISION

Burbank and Palmdale, California

PROP-JET TRANSPORTS • ANTI-SUBMARINE PATROL PLANES • JET FIGHTERS • JET TRAINERS
LUXURY AIRLINERS • AIRBORNE EARLY-WARNING AIRCRAFT

FROM EXPERIENCE COMPETENCE

TO MEET YOUR MOST CHALLENGING PROBLEMS

ASTRIONICS • AVIONICS • INSTRUMENTATION

Whether you're pondering a perplexing chess gambit or developing a data acquisition system . . . experience makes the difference.

Radiation, Inc., a pioneer in relatively new areas of research and development, offers you practical experience coupled with skill and training. But, even more, Radiation offers you the verve and vigor that often finds the solution beyond existing horizons.

If you seek a firm with *proven* solution-finding skills, send for our record of achievement.

Simply specify the field of endeavor that interests you most — Antenna Development, Telemetry, Data Systems, Missile Checkout, Instrumentation, Radar Reflectivity, or Counter-measures.

****The "Chess Pieces" shown are Radiation's telemetry tracking antenna, Vanguard data processing trailer, missile checkout system.*

RADIATION INC.

MELBOURNE AND ORLANDO, FLORIDA

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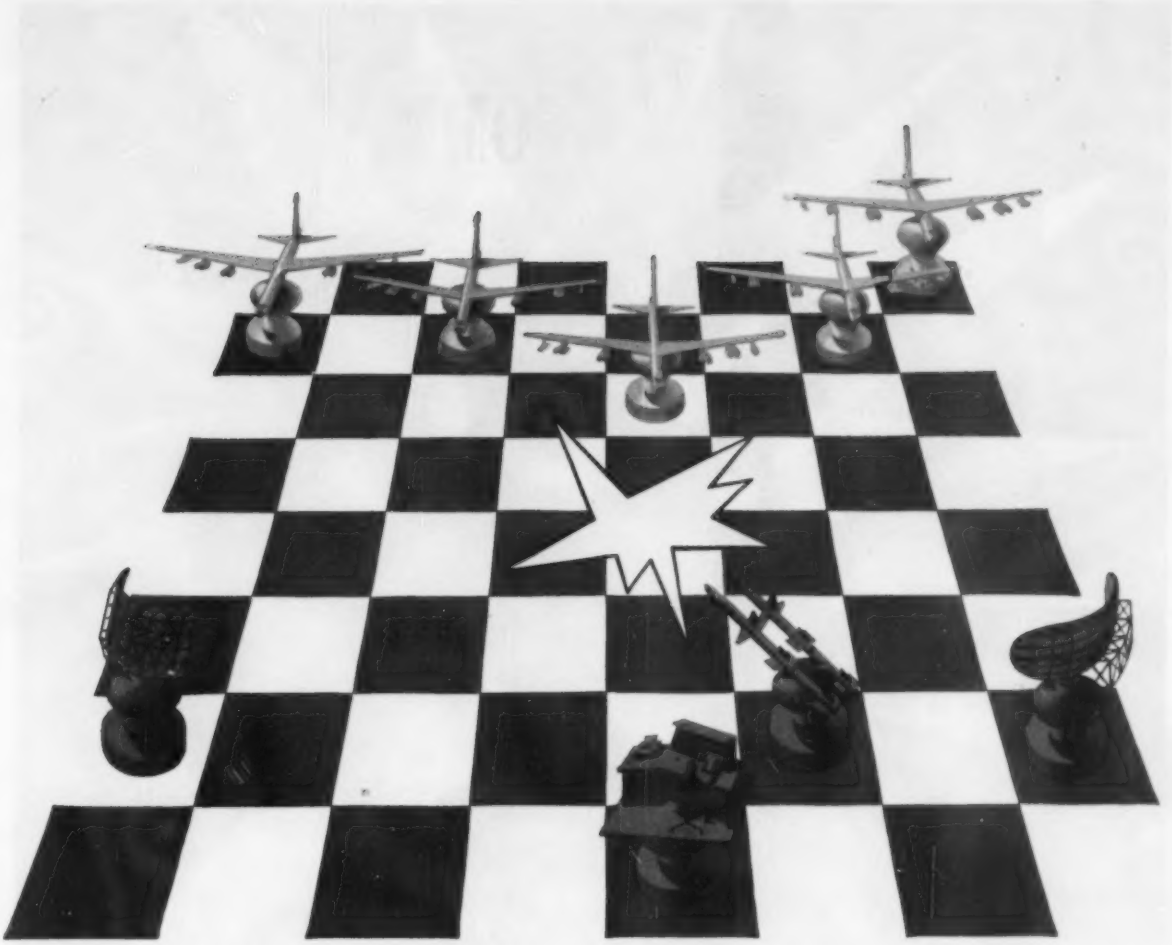

CHECKMATE

in the face of enemy countermeasures

Air Defense is a chess game for keeps—a game in which our nation and the rest of the free world are the stakes. The strategy of the game anticipates enemy actions and countermeasures and provides for that extra measure of ability to win.

At Bendix, the capability to operate in the presence of enemy countermeasures is inherent in system design.

All types of countermeasures—deception, multiple-jamming, and camouflage—are included in Bendix threat evaluation. The effectiveness of these countermeasures is investigated for advanced detection, raid resolution, tracking, and weapon control techniques.

Facing up to the sophisticated threat is the prime objective of Bendix in air defense projects. The Systems Division, working cooperatively with the Radio Division, is engaged in programs involving passive techniques, electronic scanning, frequency diversity, data processing, anti-jam circuits, special radars, bistatic detection, and anti-submarine warfare.

Other projects for which the Bendix Systems Division has system management and engineering responsibility are the EAGLE air-to-air missile system, global weather reconnaissance, supersonic target drones, and radiation-resistant mission and traffic control. These programs and emphasis on counter-countermeasures exemplify Bendix Systems leadership.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

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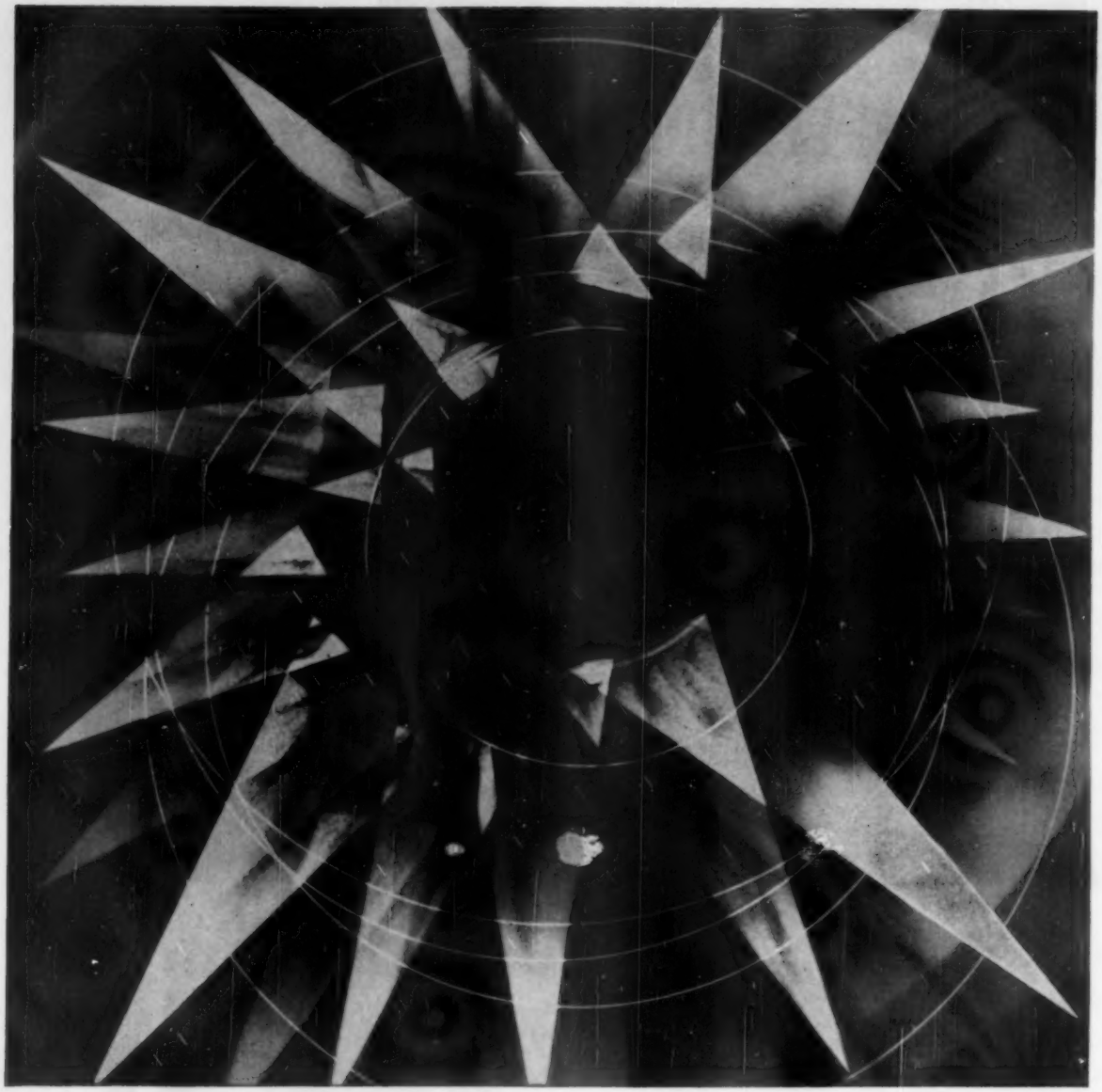

breaking the barriers
with Vacuum Induction Metals

Today's challenge lies in developing metals and means of cracking the thermal barrier.

The metals problem has already been partially solved by superalloys produced through Vacuum Induction Melting. This process, as developed by Kelsey-Hayes, has yielded such super refractory alloys as Udimet 500, 600 and 700—clean, pure alloys combining unsurpassed stress-rupture life with superior high tensile strength above the 1500°F range.

In addition to making new superalloys, Kelsey-Hayes upgrades existing alloys through vacuum induction melting.
Kelsey-Hayes Co., Detroit 32, Michigan.

Vacuum Induction Melting Develops

- *High temperature corrosion resistance*
- *Increased ductility*
- *Extreme cleanliness*
- *Precise chemical control*
- *Longer stress-rupture life*
- *Increased tensile strength*
- *Better fatigue resistance*
- *Greater yield strength*
- *Greater impact resistance*
- *Greater creep properties*

KELSEY-HAYES

Automotive, Aviation and Agricultural Parts • Hand Tools for Industry and Home

18 PLANTS: Detroit and Jackson, Michigan; Los Angeles; Philadelphia and McKeesport, Pennsylvania; Springfield, Ohio; New Hartford and Utica, New York; Davenport, Iowa; Clark, New Jersey; Windsor, Ontario, Canada.

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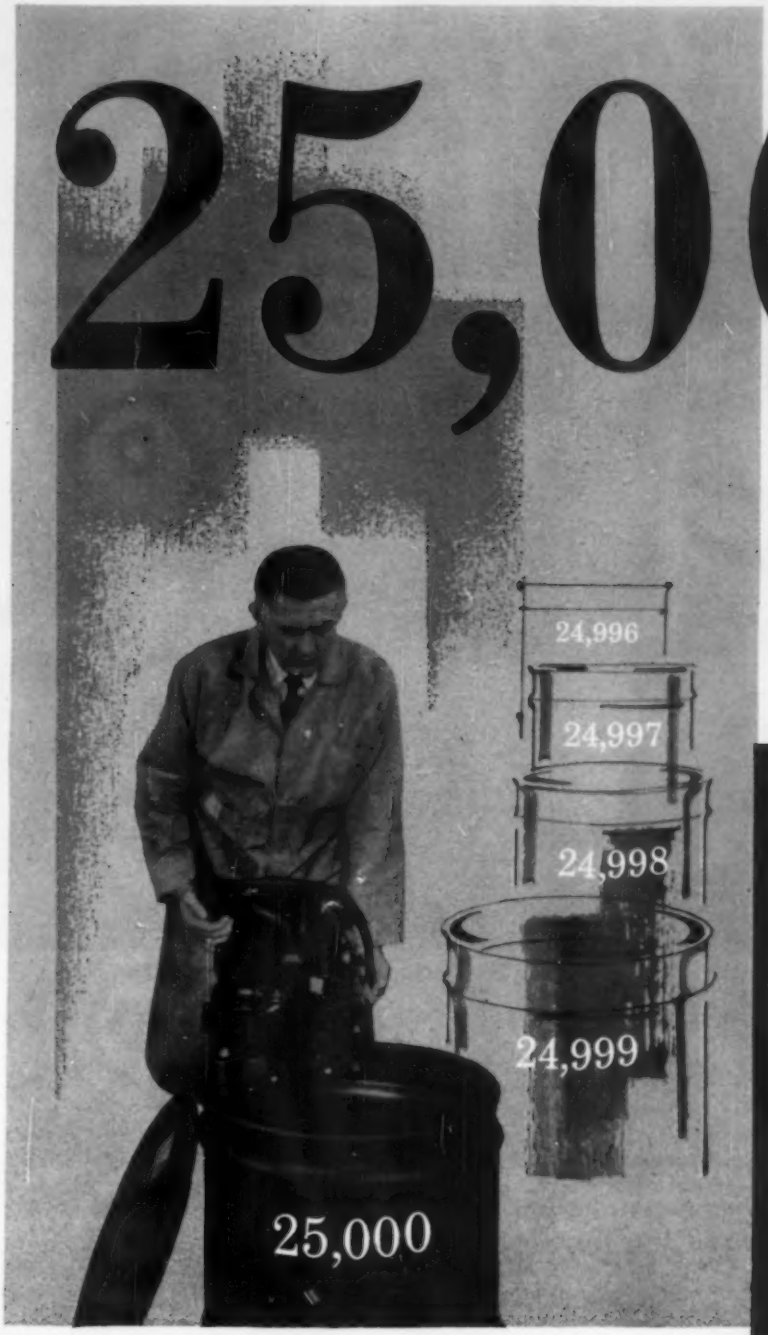
25,000



25,000
SUNDSTRAND CONSTANT SPEED DRIVES HAVE BEEN DELIVERED

for 36 major aircraft and missile programs.

6,000,000
DRIVE FLIGHT HOURS ON ALL TYPES OF AIRCRAFT

Sundstrand now brings this unequaled experience to commercial aviation . . . all Boeing 707 and Douglas DC-8 airline operators will use Sundstrand Constant Speed Drives.

SUNDSTRAND

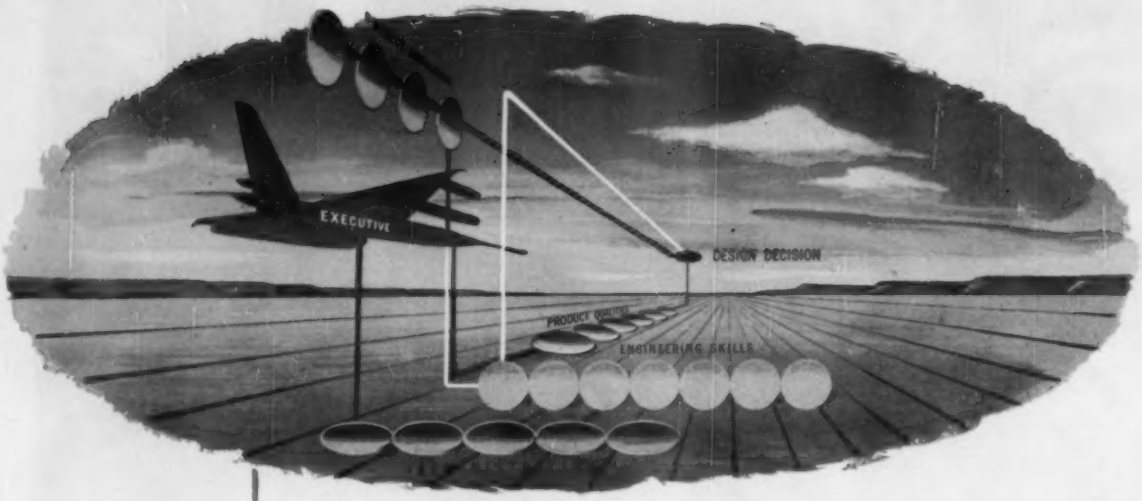
SUNDSTRAND AVIATION

Division of Sundstrand Machine Tool Company, 2411 Eleventh Street
Rockford, Illinois

District Offices in: Arlington, Texas; Hawthorne, California; Rexdale, Ontario; Rockford, Illinois; Seattle, Washington; Stamford, Connecticut, Washington, D. C.

Circle Number 44 on Reader-Service Card

a new perspective...



Convair's Engineering Organization

To develop the best and most creative abilities from the individual, and to coordinate thinking and activity in a manner that is efficient and rewarding — a new perspective in engineering organization at Convair-Fort Worth. The effectiveness of the plan is being demonstrated daily, and is best exemplified by the all-new B-58, America's first and fastest supersonic bomber . . . brought from concept to reality in record time.

Men of training and experience, seeking a more stimulating call on their creative ability, are invited to investigate Convair-Fort Worth. A card or letter will bring greater detail, or send a complete résumé of your background for evaluation by other engineers in the areas best suited to your qualifications.

ALL INQUIRIES STRICTLY CONFIDENTIAL

Please address P. O. Box 748A

CONVAIR FORT WORTH

FORT WORTH, TEXAS

CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

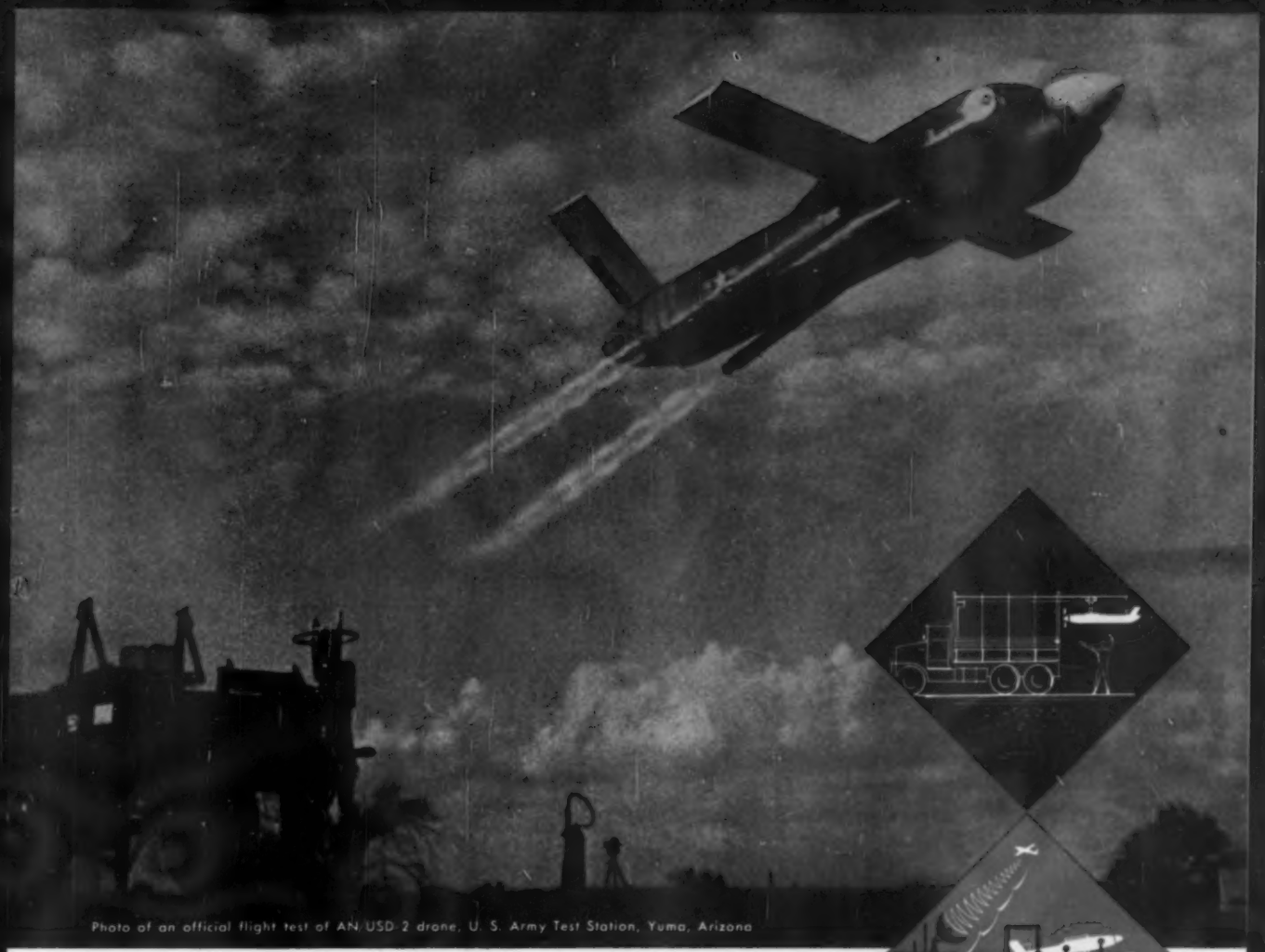
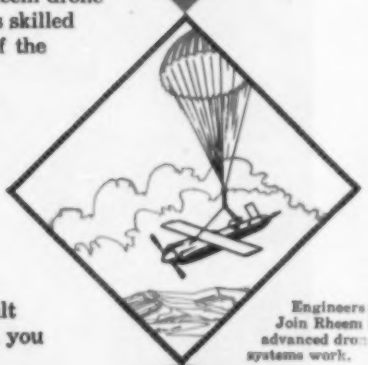


Photo of an official flight test of AN/USD-2 drone, U. S. Army Test Station, Yuma, Arizona



MISSION ENSURED

with a reliable RHEEM drone system

From launch to touch down, a Rheem drone can be counted on. Behind every Rheem drone system is the rich accumulated experience of hundreds of engineers and technicians skilled in aeronautics, electronics, and ordnance. Backing up this talent are thousands of the nation's best production workers.

Typical of Rheem capability in the design and production of complete drone systems is the U. S. Army Signal Corps Project, the AN/USD-2. From initiation to successful flight test, this surveillance drone project was accomplished in just twelve months at the Downey, California, plant of the Rheem Defense and Technical Products Division. Rheem ingenuity and know-how provided not only the drone airframe but also important components of the telemetering and ground support systems.

For combat surveillance or high-flying air-to-air targetry . . . for anti-submarine warfare or anti-missile defense training . . . whatever the requirements, consult Rheem for reliable drone systems that can be brought to reality in less time than you would think possible.

For more information on Rheem drone systems, write for Data File AW-704-3.

Engineers: Join Rheem in advanced drone systems work.

RHEEM MANUFACTURING COMPANY

Defense and Technical Products Division

11711 woodruff avenue, downey, california

Circle Number 45 on Reader-Service Card

AN ASW SYSTEM... DISPLAY/AIRBORNE RECEIVER/SONOBUOYS

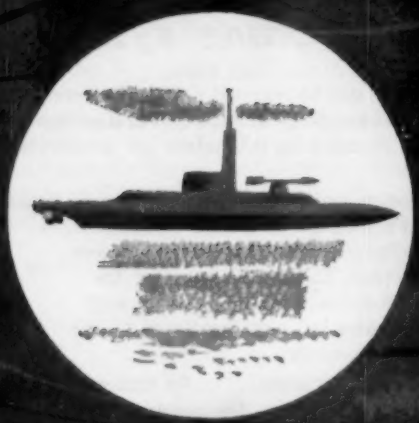
Anti-submarine warfare equipment designed, developed and produced by *The Magnavox Company*, in conjunction with the Navy Department, provides patrol aircraft with eyes that see underwater by day and by night. The AN/ASA-16 Display System, together with SONOBUOYS, AN/ARR-26 Receiver systems and other associated equipment provide aircraft with a clear picture of the ocean-depths below them. They are part of the continuing contributions of *The Magnavox Company* in aiding the U.S. Navy to combat the growing submarine menace.

MAGNAVOX capabilities are in The Fields Of Airborne Radar, ASW, Communications, Navigation Equipments, Fusing and Data Handling . . . your inquiries are invited.

PRODUCTS
THAT SEE BY
THEMSELVES

Magnavox

GIVES EYES TO NAVY ANTI-SUBMARINE WARFARE UNITS!



COMMUNICATIONS

RADAR

DATA HANDLING

ASW

MISSILES

THE MAGNAVOX CO. • DEPT. 55 • *Government and Industrial Division* • FORT WAYNE, IND.

Circle Number 46 on Reader-Service Card

Boeing 707's 98 windows are triple-glazed with PLEXIGLAS. Outer and middle panels are made of stretched PLEXIGLAS 55.

"Where there's Progress, there's Plexiglas"

PLEXIGLAS *is a trademark, Reg. U.S. Pat. Off. and in principal countries in the Western Hemisphere.*

Canadian Distributor: *Crystal Glass & Plastics, Ltd., 130 Queen's Quay East, Toronto, Ontario, Canada.*

Chemicals for Industry

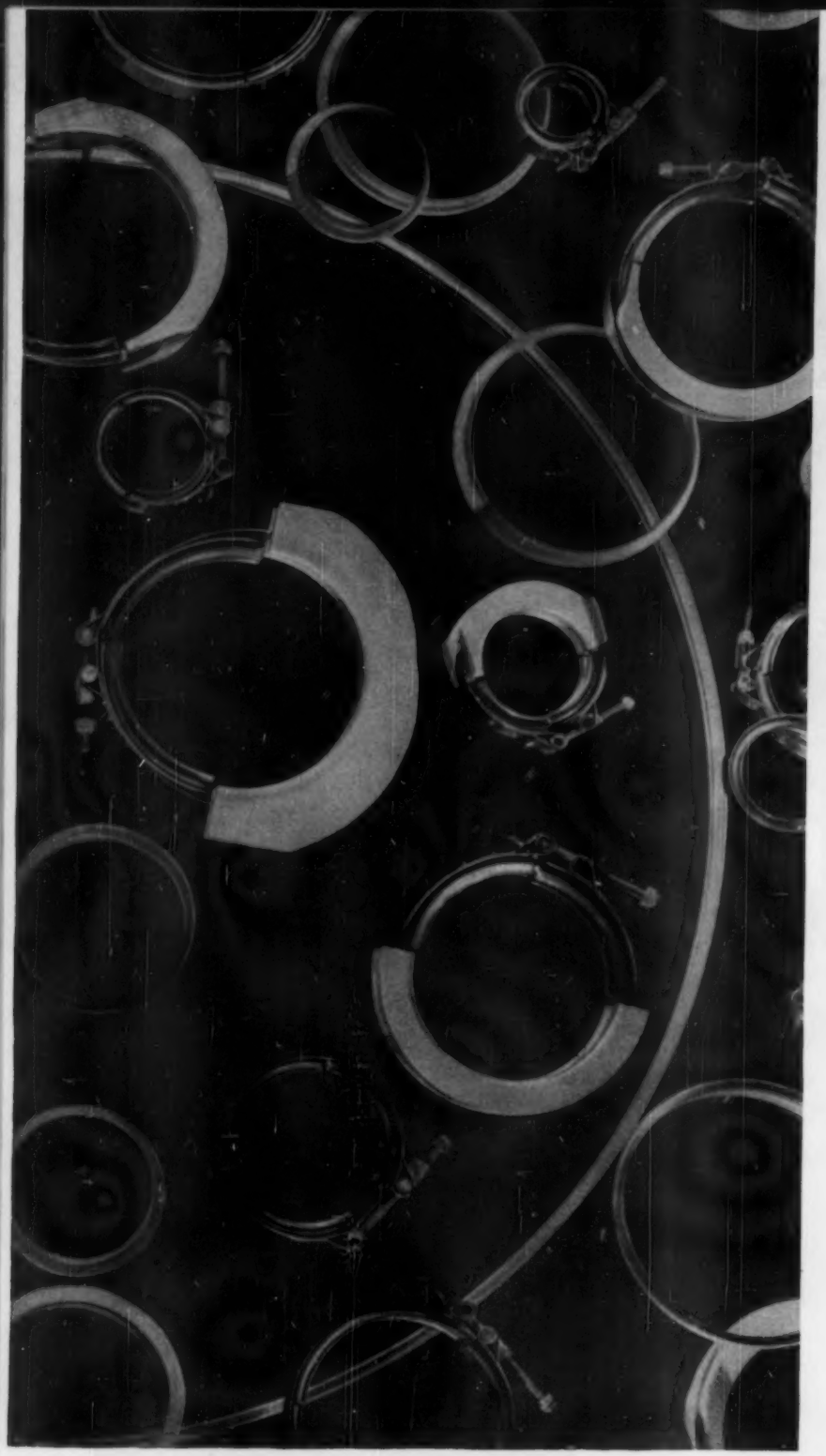
ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

Circle Number 47 on Reader-Service Card

Circle Number 48 on Reader-Service Card



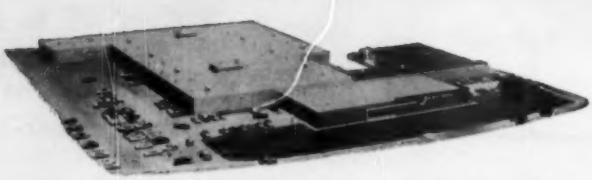
reliable couplings unlimited

Metal-to-metal seal—pressure tight after repeated disconnects—reliable under vibration, surges, shock, misalignment, high and low temperatures and pressures. Designs to 400 psi. pressure, 1000° F. Materials are stainless steel, aluminum or titanium. Easiest to use in close quarters.

Janitrol bleed air duct couplings are available in two lines with a complete range of sizes to 6 inches: Standard Line and Janitrol's Dubl-Lock* line for maximum reliability. And Janitrol's special couplings to 36 inches and more are ideal for quickly connecting and disconnecting jet tail pipes or missile sections.

Janitrol duct supports can be included as a part of the clamp or separately. Ask your nearest Janitrol engineering representative for a proposal.

**Trademark of Surface Combustion Corporation*



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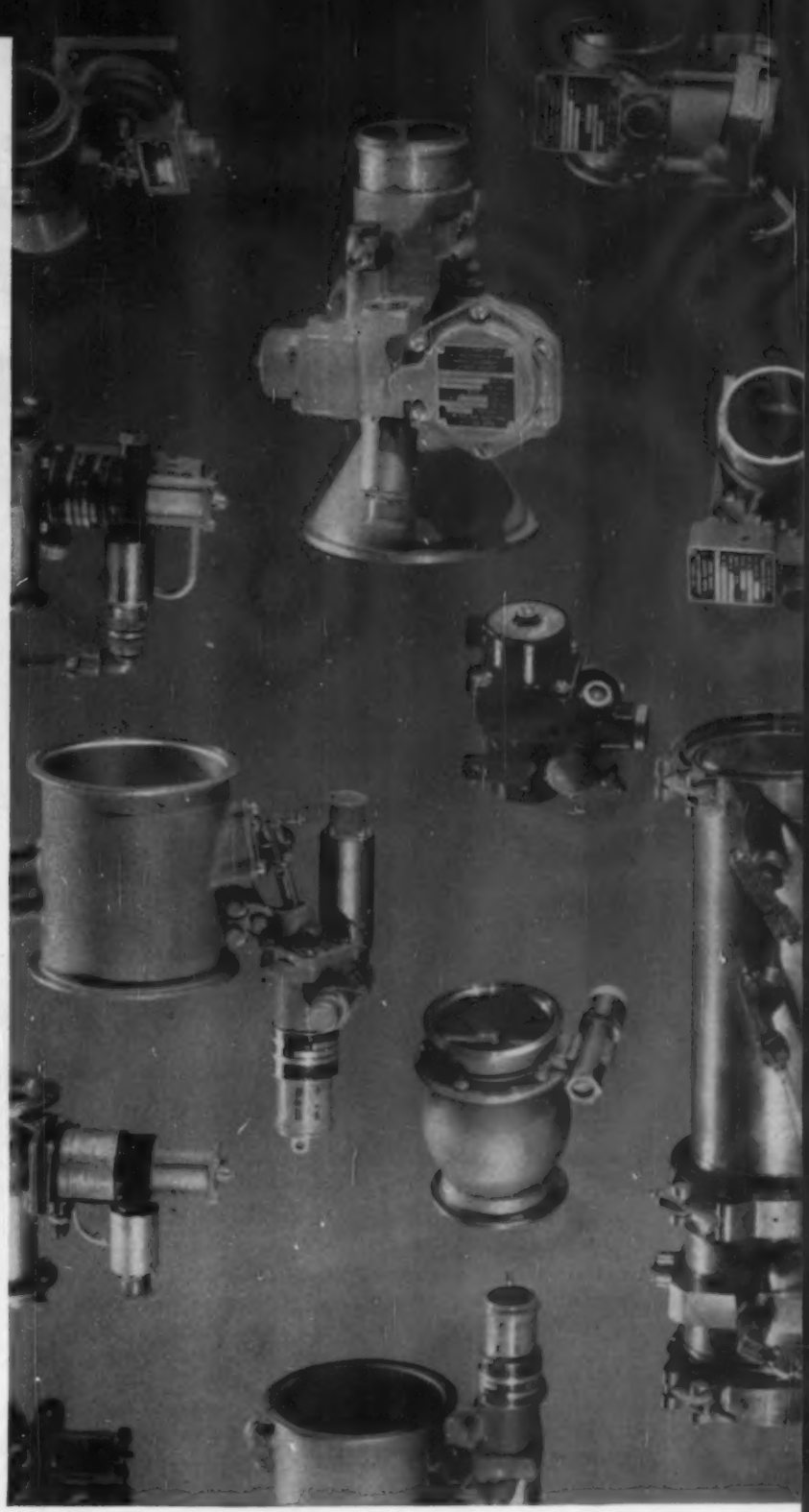

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Aviation Week
Including Space Technology

Volume 70
Number 10

March 9, 1959

TWENTY-SIXTH ANNUAL INVENTORY OF AIRPOWER

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AVIATION WEEK including SPACE

Aviation Fights Squeeze on Profits

The aviation industry and its related technologies will continue to maintain gross revenues of over $12 billion during 1959—slightly higher than the $11.8 billion gross for 1958.

Defense spending for aircraft, missiles, avionics, space vehicles and research and development will continue at the increased level of the final half of 1958 with some possibility, contingent upon congressional pressure and increasing international tension, for a substantial increase above even this volume. Commercial sales of jet transports and business flying aircraft will show a sharp rise during 1959, hitting close to $2 billion for the year.

At the same time that a continued high level of business activity is in prospect for 1959, the industry faces a critical fight against major government policies that have steadily whittled its percentage of profit on sales and reduced its net income during the past four years. Success of the industry in obtaining relief from restrictive and unrealistic government fiscal and regulatory policies will be more significant in determining net income for 1959 than gross sales volume.

Here is how military spending breaks down for Fiscal 1960 (beginning in July, 1959):

- **$6.2 billion for aircraft, engines, airborne avionic equipment and related procurement.**
- **$3.8 billion for missiles and related equipment, including rocket engines, guidance and ground handling and checkout equipment.**
- **$2.1 billion for research and development, the vast bulk of which is devoted to aircraft, missiles, space technology and avionics.**
- **$333 million for civil space technology research by the new National Aeronautics and Space Administration, including the specific projects detailed in Aviation Week (Mar. 2, p. 19 through 23).**

Keith Glennan, chief of NASA, told Congress last month that Fiscal 1960 will be the last year this agency will require as little as $500 million for its activities, with an estimated growth to more than $1 billion annually thereafter. Although NASA has acquired a large "in-house" research capability by absorbing other government facilities, its policy is to depend upon industry to build its hardware, and it already has let substantial contracts with McDonnell, North American Aviation, Thiokol, Aerojet, Convair and others for rocket and space capsule developments.

Space technology is still basically a research and development activity, although some specific military weapon systems such as the WS-117L reconnaissance satellite and Project MIDAS are already under active development. However, its requirements encompass the same broad field of technology in which the aviation industry has traditionally worked such as propulsion, guidance, structures, artificial environments, etc. A stake in this research and development phase of space technology is vital to any industrial firm that hopes to continue in this expanding and still dimly perceived technological area.

INDUSTRY BACKLOG

Industry Backlog at the beginning of 1959 was about $13 billion, with a total employment of 760,000 workers, rising from a low of 742,000 in mid-1958. Employment is expected to remain stable at about that level during the year, with an increasing demand for engineers, scientists and technical specialists.

New business outlook during 1959 looks promising in the military fields, space technology and business flying, with dimmer prospects likely in the jet transport and helicopter markets. Defense Department budget for Fiscal 1960 calls for direct obligations (new contracts), totaling $13.4 billion, including $6.7 billion for aircraft, $3.7 billion for missiles and $3.7 billion for research and development.

Major problem for the industry during 1959 will be to fight successfully against the combination of circumstances that has been steadily squeezing its net income lower despite increasing gross revenues. Orval Cook, president of

the Aircraft Industries Assn., reported in his 1958 industry review that the average net profit as a percentage of sales of the 12 largest manufacturers in the field has been declining steadily since 1954, from 3.7% for that year to 2.4% in 1957 and just above 2% for 1958. Clearly, the industry cannot continue to perform the tasks demanded of it for national defense, particularly the financing of heavy research and development expenditures, if its rate of return continues at this low level.

Biggest factor in this situation is antiquated procurement legislation and regulatory procedures that are totally inadequate to meet the technical and fiscal requirements of modern defense industry.

MAJOR TREND

MAJOR TREND DEVELOPING in the defense business is the financing of production programs for fewer but more technically complex and more expensive weapon systems. This rapid pace of technical development means the end of the large post-war production runs such as the 2,000 B-47s built by the Boeing-Douglas-Lockheed consortium or the 7,000 Sabres turned out by North American. This trend has produced two new features of industrial operations that will broaden during 1959. They are:

• **Heavier emphasis on research and development** that will require larger expenditures of private funds, both for research and test facilities and also for state of the art development work not specifically tied to a particular weapon system program.

• **Combination of firms** in a technical consortium to handle major weapon system management programs too complex technically for any single industrial organization to tackle individually. The combination of Convair and RCA in tackling the Wizard anti-ICBM program, Boeing-Chance Vought and Martin-Bell teams heading similar amalgamations for the Dyna-Soar program and the consortium of communications firms headed by IT&T to tackle the USAF strategic communications problems are typical of the new pattern developing.

• **Wider subcontracting** from the winners of prime weapon system contracts to their less fortunate competitors. North American B-70 and F-108 Mach 3 bomber and fighter programs illustrate the trend with nearly 70% of the total production program subcontracted, including major assemblies to Convair, Boeing, Lockheed and Vought.

COMMERCIAL OUTLOOK

THE AIR TRANSPORT INDUSTRY is heading for its first major test in absorbing jet technology into its operational and economic structure.

First major system operations of jet transports will begin during this year and are expected to produce the first valid data on how this trend will really affect the airline picture.

Passenger traffic will increase close to 10% during the year, continuing the rising trend of the final quarter of 1958 with gross airline revenues estimated at $2.7 billion for 1959. Cargo will continue to rise slowly in volume. Net income should increase for the trunklines over the $40 million total for 1958 even without any further fare increases.

U. S. flag airlines, both international and domestic, will face increasing competition from their foreign rivals for U. S. traffic rights as a reshuffling of bilaterals and traffic rights for the jet age is sought by foreign governments.

Business flying had a good year in 1958 despite the problems that beset other segments of the industry. Business plane manufacturers hit a gross sales value of $133 million for a $10 million increase over 1957. Prospects for growth close to $150 million sales loom for 1959 with major re-equipment pending for the business fleet in the five-year period extending to 1962 when small jet transports will become available. Total sales volume of $1 billion for this period has been forecast by the Federal Aviation Agency.

Helicopters face another austere year as both civil and military customers plan to defer large scale re-equipment programs until gas turbine powered models are in production.

Future prosperity of the aviation industry and its contribution to the national defense and international transport system will depend in large measure on how well its problems and products are understood by the American public, which pays for defense and uses its transport facilities, and by the legislative and executive branch of the government.

—Robert Hotz

Master Flight Reference

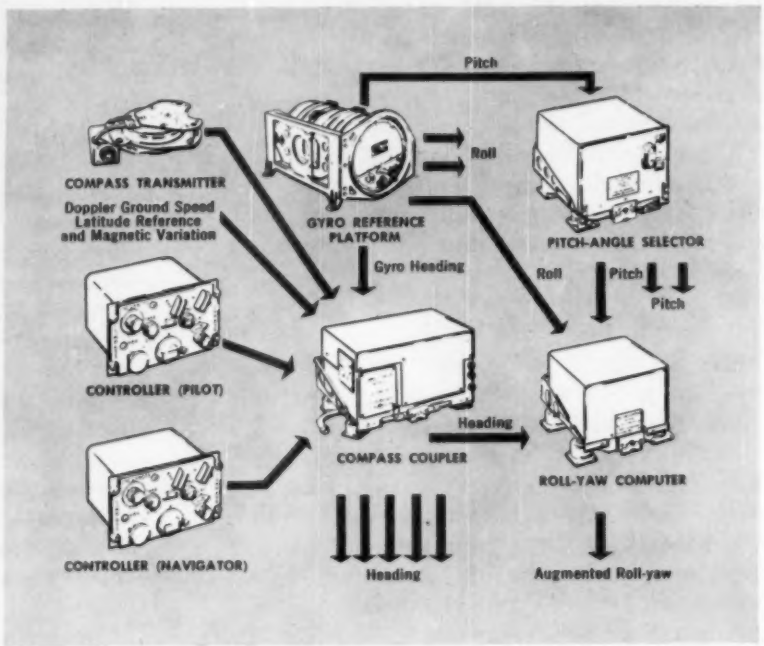
New General Electric Master Flight Reference System integrates direction and attitude changes; guides supersonic aircraft through intricate maneuvers such as over-the-shoulder and toss bombing

A new navigational sub-system, designed to help solve the problem of integrating the various elements of flight control at supersonic speeds, has been developed by the General Electric Instrument Department. Designated the SR-1 Master Flight Reference System, this electronic "brain" is already being used to guide some of our fastest jets in intricate maneuvers such as over-the-shoulder and toss bombing, Immelman turns, and cuban-eights.

Basically a direction and attitude reference sub-system, the General Electric SR-1 (Navy designation AN/ASN-26) accurately senses roll, pitch, and yaw change signals by means of three single-axis gyros. These changes are then converted into multiple signals and automatically relayed to aircraft radar, autopilot, dead-reckoning and navigational computers, bombing equipment, and all-attitude indicators.

General Electric engineers have designed the Master Flight Reference System around six basic components:

1. A three-gyro, four-gimbal, all-attitude stable platform from which flight reference information is transmitted.
2. A small remote compass transmitter which furnishes an accurate heading signal and is used in conjunction with the directional gyro platform to provide a stabilized heading direction.
3. A coupler device which receives the azimuth signal from the platform, plus any necessary correcting signals from the pilot, Doppler radar and the magnetic compass combining them to provide an accurate azimuth signal with sufficient outputs for the operation of the system.
4. A control panel located in the pilot's compartment for his use in setting in necessary information concerning mode of operation, aircraft ground speed, latitude, and synchronization of directional gyro and compass. An identical control panel may be installed for a navigator if required.
5. A servo adapter for platform pitch output which repeats platform-pitch signals for other aircraft components needing attitude information and capable of initiating the operation of any given function at a preset pitch angle.
6. A servo circuit which translates earth coordinates to aircraft coordinates during special maneuvers. It also provides true aircraft roll information for the autopilot and all-attitude indicator.



The Master Flight Reference System is just one of General Electric's many contributions to aircraft instrumentation. Other G-E aircraft instruments are used in systems that measure and indicate mass fuel-flow, engine speed, electric-quantities, temperature, and position. For information on any of these instrument systems, contact your nearest General Electric Apparatus Sales Office; or write direct to General Electric Co., Section 596-501, Schenectady 5, New York.

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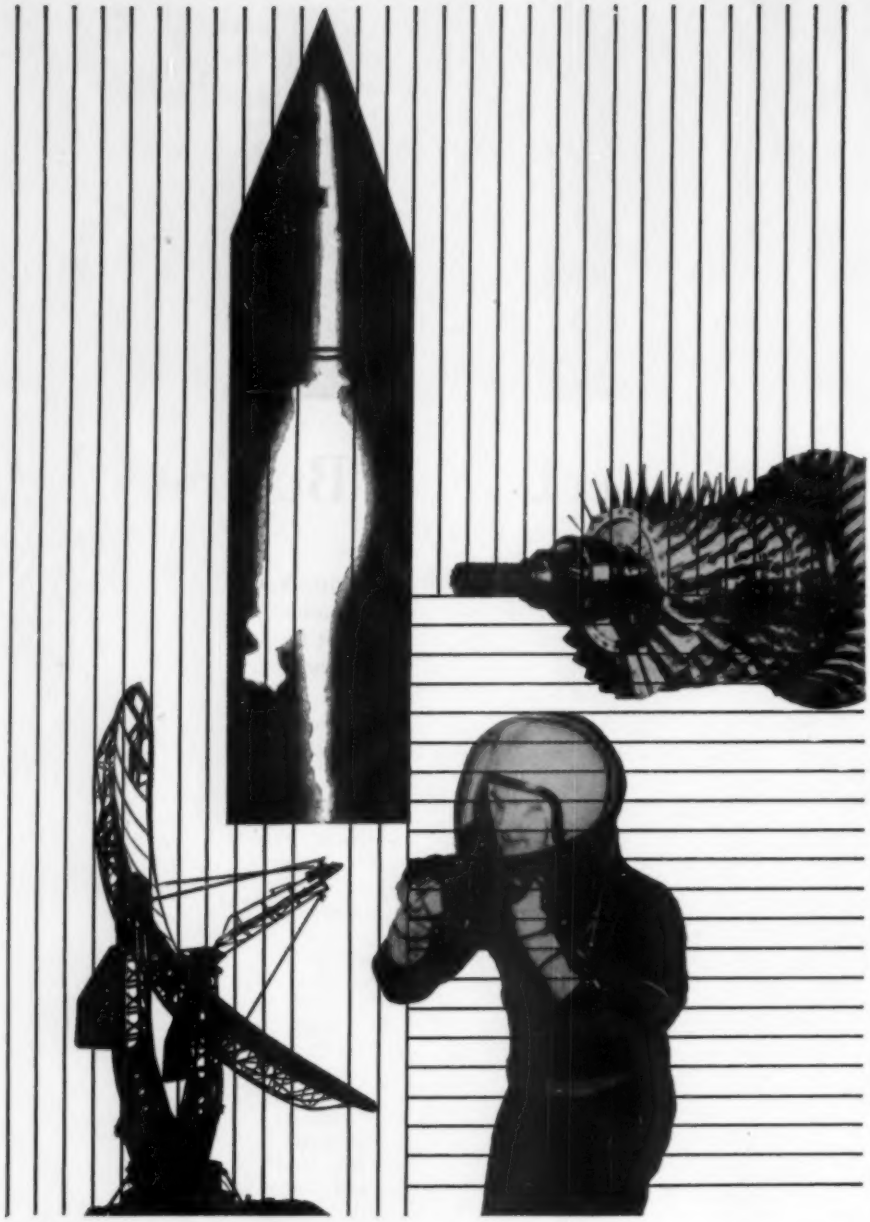

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BOEING KC-135 REFUELS BOEING B-52G

USAF Faces Technical, Budget Problems

By Robert Hotz

U. S. Air Force is facing one of the most difficult periods in its history as a combat service. During 1959 it will begin to grapple fully with the problems of integrating basically new weapons—ballistic missiles—into its combat forces while attempting to expand three major lines of technical development in the face of the limitations of a constant-level budget.

This combination of problems is imposing the most severe challenges on USAF technical, combat and political leadership since the frantic expansion of early World War II.

The three major technical development areas which are the key to USAF's future role are:

• **Manned Aerial Vehicles.** Already operating in the Mach 2 speed range and at the outer fringes of the atmosphere, USAF manned vehicle development is stretching through the hypersonic speed range and orbital flight paths and radically new propulsion to manned space vehicles.

For many USAF missions, as far into the future as can be even dimly perceived now, there will be a major requirement for manned vehicles.

• **Ballistic Missiles.** This type of delivery system has become an important new addition to the USAF strategic deterrent. But it can never perform the full range of aerial mission requirements.

Although the first type of ballistic missile has proved system feasibility, there is a vast development requirement for the future in improved propulsion, guidance, warheads, servicing equipment and operational techniques and defensive systems.

• **Space Technology.** Although space technology is still in its early phase of basic exploratory research, there are already strong possibilities of military value in the immediate future such as reconnaissance, weather and communications satellites. The full military implications of space operations cannot be determined until considerably more basic exploratory research data is accumulated. But this has already been stamped as a field where USAF cannot afford to lag either in research and development or in eventual useful weapon production.

Faced with an increasingly heavy research and development load, USAF has been struggling unsuccessfully with the task of obtaining sufficient funds for personnel, maintenance, fuel, construction and production of weapons to maintain the force levels it set as its post-war goal. From a maximum strength of 127 wings achieved just after the Korean war ended, USAF's wing strength has declined to 105 wings in Fiscal 1959, with a further reduction to 102 wings, including missile units, during Fiscal 1960. Strategic Air Command will maintain a level of 43 wings, with its heavy bomber wing strength boosted from 30 to 45 planes each.

Wing Cutback

Tactical Air Command will lose one of its 35 wings in Fiscal 1960, and Air Defense Command will drop two interceptor wings in the Fiscal year from its current total of 22 wings.

This is the first year in which USAF has had to cope with the dual problem of defense against both manned aerial vehicles and ballistic missiles. This dual nature of its defense problem will grow more acute in the future as the Soviet threat continues to grow in both areas and domestic pressure continues to increase to abandon one defensive capability to concentrate on the other.

Three trends in coping with this dual defensive problem will be:

• **Dispersal.** Both ICBM and bomber bases will be dispersed as widely as is practicable within operational and budgetary limitations to increase the size of the Soviet ICBM force required for a reasonable chance of immobilizing these retaliatory forces in an initial surprise missile attack. However, by 1962 there will probably be no more than 50 SAC bomber bases and 20 ICBM bases completed in the U. S.

• **Hardening.** Fantastic amounts of concrete will be poured into SAC missile and bomber bases and air defense centers during the next five years to make them more resistant to the blast

USAF Planes on Hand

(End of Fiscal Year)

1958	22,00
1959	20,80
1960	19,98

Force Levels

Following military airpower force levels are scheduled for the end of Fiscal 1960:

USAF—102 wings

NAVY—16 carrier air groups
22 carrier anti-submarine squadrons
42 patrol and early warning squadrons
3 Marine air wings

U. S. Plane Inventory

(End of Fiscal Year)

	1959	1960
USAF	20,800	19,98
NAVY	9,500	9,10
ARMY	5,289	5,36
TOTAL	35,589	34,44

● USAF

and radiation damage from megaton missile warheads. Atlas, B-58 and Bomarc bases will be semi-hardened, with missiles and aircraft housed in concrete shelters, while B-70, Titan and Minuteman bases will be completely hardened with underground storage, servicing, launching and control centers protected by heavy concrete sheaths. The SAGE air defense control centers now extremely vulnerable to enemy missile or bomb attacks will also be reduced in size and complexity through use of transistors and then encased in concrete shelters.

• **Warning.** Current operational radar equipment cannot give adequate warning of ballistic missile launchings over the ranges required. Although some strategic warning of an impending enemy missile attack may be possible—Gen. Nathan F. Twining, chairman of the Joint Chiefs of Staff, told Congress this could be as much as two hours—there is little opportunity for direct technical warning by present radar installations. For advance bases overseas, zero warning time is most probable with less than 20 min. likely for U.S. bases.

Major efforts are already under way to develop better technical warning devices both for the immediate future—Ballistic Missile Early Warning System (BMEWS) sites now are being readied in Greenland, Alaska and Scotland—and there are long range studies (GLIPAR, AW Mar. 2, p. 18) for radically new approaches to the problem. Continued emphasis on continuously mobile warning systems appears necessary in contrast to the fixed locations of DEW, mid-Canada and Pinetree line radar stations that now make them extremely vulnerable to ballistic missile attack.

Strategic Air Command is still the most powerful arm of USAF combat strength and the keystone of U.S. foreign policy. But SAC is beginning a period of radical transition imposed both by the technology of new weapons development and the shifting balances of international power. SAC was most effective as a military force and a foreign policy instrument during the decade just ended when its capability for long range megaton bomber delivery was literally unique in the world and its dominance in this area was unquestionably and significantly superior to any possible foreign competitor.

Now SAC is facing an increasingly strong challenge both to its ability to penetrate to possible targets and to its ability to maintain a militarily tenable position from which to launch its strategic deterrent. This challenge comes from the forced draft development of Soviet offensive and defensive capabilities in modern weapons and from the artificial budget limitations that have been imposed by U.S. government policy during the past five years. SAC, caught in both jaws of this slowly closing vise, faces extraordinary technical development and operational problems in order to maintain the same relative position in the next decade that it so successfully held in the last.

Current SAC strength consists of about 2,000 megaton-carrying jet bombers. Of this force about 1,500 are the aging and short-legged B-47. Only 500 are the newer and longer-ranging B-52. It was only last month that SAC phased out its last piston powered B-36 bomber. The B-47 fleet still offers some genuine combat capability but it is sliding fast down the obsolescence curve.

Its chief advantages lie in the numbers of its fleet which would drive toward saturation of enemy defenses plus its deployment in widely dispersed bases around the Soviet perimeter, with a significant portion of its force on the 15-min. runway alert of Operation Reflex.

Its disadvantages lie in its speed, altitude and range limitations, the latter influenced by its dependence on the slower and older KC-97 tankers that force the B-47 down to inefficient operational altitudes for refueling operation. In addition the B-47 fleet is simply wearing out. Operation of high subsonic aircraft over a period of years apparently induces metal fatigue problems much sooner than in slower aircraft. Project Milk Bottle is aimed at temporarily reinforcing B-47 structure but there are serious questions being raised within USAF as to just how much longer the B-47 can function as an efficient flying machine regardless of its combat obsolescence.

Thus the hard core of SAC for the next five years will be its B-52 fleet serviced by KC-135 jet tankers that can transfer fuel at the speeds and altitudes most compatible with jet bomber operations.

By next July, Strategic Air Command will have 11 combat-ready wings of Boeing B-52s with a normal complement of 45 bombers per wing, with another wing now in process of conversions to B-52s and two more full strength wings to be added before the end of 1960. This will provide an operational force of about 630 B-52s.

Close to 230 KC-135 jet tankers have already been delivered to USAF with production continuing at Boeing's Renton, Wash. plant.

Although the B-52 delivery problem increases with the improvements in Soviet air defenses this bomber has considerable technical stretch left to substantially improve its operation capability. These include:

• **Increased range without refueling.** B-52G now in production at Boeing's Wichita plant has a major range increase over earlier models and a further 33% range increase is in prospect over even the Model G performance through retrofit to Pratt & Whitney J57 turbofan engines. B-52G with conventional J57 turbojets is expected to enter operational service with SAC this spring.

• **Increased electronic countermeasures** capability. B-52 will soon be equipped with McDonnell Green Quail ECM decoy missile in addition to a wide variety of other ECM equipment.

• **Air to surface missiles.** North American Hound Dog turbojet powered supersonic missile will carry a nuclear warhead with inertial guidance over ranges up to 400 mi. from its B-52 launching platform. B-52 can carry a pair of Hound Dog missiles, one under each wing, in addition to its major megaton bomb load carried internally.

B-52 is also being considered as a launching platform for the USAF's WS-138A air launched ballistic missiles with ranges up to 1,500 mi. although this weapon will undoubtedly see more use with the B-70 Mach 3 bomber or the CAMAL nuclear powered aircraft.

As a replacement for the subsonic and aging B-47, SAC is introducing the Mach 2 Convair B-58 delta wing bomber with the first squadron scheduled for activation this fall. Present USAF programing indicates the B-58 fleet may eventually total 200 aircraft but only 106 have been financed through Fiscal 1960.

Two replacements already loom on the technical horizon for the B-52 fleet. They are:

• **North American B-70 Mach 3** intercontinental bomber powered by General Electric J93 turbojets. Officially named the Valkyrie, the B-70 will operate initially on regular jet fuel but in later phases will utilize exotic fuels, probably involving boron compounds for improved performance. The B-70 will be capable of intercontinental ranges without refueling and will be primarily an airborne missile launching platform for ALBM type missiles. B-70 is expected to arrive in the SAC operational picture in the early 1960s.

• **CAMAL nuclear bomber** powered by General Electric direct air cycle nuclear-fueled turbojets.

Nuclear powerplant development for CAMAL has been funded on a mini-

CONVAIR B-58 MACH 2 BOMBER WITH POD

REPUBLIC F-105 IN LOW LEVEL FIRING PASS

DOUGLAS C-133 CARGOMASTER LOGISTICAL TRANSPORT

mum basis for several years. Only airframe study contracts have been authorized for Lockheed and Convair. Fate of the CAMAL program or any similar nuclear powered aircraft concept hangs in balance pending outcome of public congressional hearings on the program. USAF and AEC plans to make $45 million additional available for the program in Fiscal 1959 were recently vetoed by Deputy Secretary of Defense Donald A. Quarles and Presidential Scientific Advisor James R. Killian, Jr.

Beyond these two projects, early development work is already under way on the Dyna-Soar program aimed at producing a manned orbital bomber operating at hypersonic speeds. Two teams, one headed by Martin and Bell and the other led by Boeing and Chance Vought are currently competing with design proposals for a Dyna-Soar vehicle.

In the guided missile field SAC will get its first intercontinental missile capability by July when the wing equipped with subsonic Northrop Snark missiles is scheduled to achieve operational status at its Limestone, Me., base. SAC ICBM program calls for 20 squadrons deployed by the end of 1962, of which nine will be equipped with the Convair Atlas and 11 with the Martin Titan. Five Atlas bases have been announced. They are:

- **Vandenberg AFB** near Lompoc, Calif., which is also an operational training base and part of the Pacific Missile Range.
- **Cheyenne, Wyo.**
- **Spokane, Wash.**
- **Omaha, Neb.** (near SAC headquarters).
- **Topeka, Kan.**

Only Titan base publicly located so far is near Lowry AFB, outside Denver, not far from the Martin Titan production plant.

Initial Atlas bases will be soft, with missiles, servicing and guidance equipment located above ground in relatively protected areas. Early operational Atlas bases will be semi-hardened with missiles and supporting equipment protected in concrete buildings until actual launch procedures begin. Most vulnerable portion of the Atlas base complex is the guidance antenna for the combination radio-interial guidance system on early model missiles. Later shift to full inertial guidance plus rise in internal pressure of the Atlas missile shell will permit use of this missile in fully hardened underground launching sites.

First operational Series D model Atlas missiles with range of 7,600 naut. mi. will be delivered to SAC this summer for training purposes at Vandenberg AFB. Portions of two squadrons will be in some state of operational readiness at Vandenberg and Cheyenne by the end of the year with the first full ICBM squadron capability scheduled for achievement early in 1960. Titan is still in early development testing stage at the Atlantic Missile Range but is shooting for initial operational capability at Lowry AFB before the end of 1960.

SAC also will deploy three squadrons of Army-designed Jupiter IRBMs in Italy this year. First SAC Jupiter squadron has just completed training at the Army Ordnance Guided Missile School at Redstone Arsenal, with the second well into training and the third squadron about to begin this summer. SAC also has programed a Thor squadron for Alaska some time during 1959 and plans are being discussed for further deployment of the Thor in Turkey and Greece.

Behind the Atlas and Titan liquid fueled ICBMs, USAF is developing the Minuteman solid fuel ICBM which is aimed at instant readiness in hardened, remotely controlled launching sites. USAF is counting heavily on Minuteman to give it a significant instant retaliatory capability that could survive an initial surprise missile assault by an enemy. Minuteman is still in the early development stage and even the most optimistic schedules for its operational use push well into the mid-1960s. Its warhead yield is about half that of the current Atlas and Titan warheads.

As the Soviet ICBM capability grows and its IRBM capability makes the use of foreign bases less certain, Strategic Air Command is faced with the problem of maintaining a significant portion of its striking force on airborne alert out of reach of any surprise missile attack.

While the Soviet threat was primarily from jet bombers, an airborne alert was not really required although a large portion of Congress and the American public erroneously imagined an airborne alert to have been in effect for some time. Now, however, SAC

USAF Aircraft on Order

Acft. Type	Popular Name	Manufacturer
	BOMBERS	
B-52F, G	Stratofortress	Boeing
B-58A	Hustler	Convair
	FIGHTERS	
F-100F	Super Sabre	North American
F-101B	Voodoo	McDonnell
RF-101C	Voodoo	McDonnell
F-104C, D	Starfighter	Lockheed
F-105B, D, E	Thunderchief	Republic
F-106A, B	Delta Dart	Convair
	TRANSPORTS	
C-130A, B	Hercules	Lockheed
RC-130A	Hercules	Lockheed
C-133A	Cargomaster	Douglas
KC-135A	Stratotanker	Boeing
	TRAINERS	
T-33A	Shooting Star	Lockheed
T-37A	None	Cessna
T-38A	None	Northrop
T-39	Sabreliner	North American
	HELICOPTERS	
H-43A, B	Huskie	Kaman

is facing a deadline after which it will no longer be safe to nest all of its planes on the ground even under the 15 min. alert margin of Operation Reflex. Cost of maintaining an airborne alert will impose new strains on the constant level defense budget.

Military Air Transport Service faces a major problem in its transition to the jet transport era. MATS 360-plane fleet of four-engine DC-6, Constellation and C-124 aircraft is rapidly approaching obsolescence and is particularly unsuited for the heavy payload and large cubage requirements of modern air logistics, specifically in the missile field. MATS now is operating several squadrons of Douglas C-133 turboprop transports and will eventually have 50 of these aircraft in service. The C-133 is the first genuine heavy logistics carrier to see military service and is capable of carrying IRBMs and ICBMs without crews or any support equipment.

MATS is anxious to buy existing jet transport designs modified with knelling landing gears to reduce their loading level to truckbed height and rear hinged tails for large cargo loading. The turbojet Douglas DC-8, Boeing 707, Convair 600 and the turboprop Canadair CL-44 have all been proposed with this type of equipment to meet MATS transport requirements. Funds are expected in the Fiscal 1960 budget to purchase 10 jet transports for MATS.

However, controversy between MATS and ARDC has arisen over the jet vs. turboprop powered heavy logistics carrier. ARDC feels that the turboprop is better suited to the heavy freighting job that should be the primary job of a MATS aircraft, while MATS is strongly determined to continue its long established trend of buying transports which are primarily designed for civil airline passenger transport and slightly modified to pass muster as a cargo carrier. Strong congressional scrutiny of MATS' future equipment program is expected with opposition already brewing for its proposed jet transport purchases.

North American Air Defense Command, as one of the first joint service operational commands, is a focal point for conflicting philosophies of air defense requirements and bitter interservice mission rivalry between USAF and the Army. Basic points of conflict are:

• **Area vs. point defense.** USAF is strongly committed to the area defense concept, using both long-range interceptors armed with nuclear missiles such as the Douglas MB-1 and ground-to-air missiles such as the Boeing Bomarc. Army is equally committed to point defense cluster batteries of its short ranged Nike Ajax and Hercules around major population centers.

• **Basic electronic incompatibility** of USAF and Army air defense systems. USAF interceptors and missiles are designed to work with SAGE electronic ground environment linked to search radar networks. Army has a separate electronic communications and command network that is incompatible with SAGE. This is the major reason for the move to take all future air defense systems research and development out of Army and USAF control and vest this responsibility directly in the Assistant Secretary for Research and Engineering using the Mitre Corp., an M.I.T. group, as technical adviser and supervisor.

• **Basic differences over the approach** to the anti-missile defense problem. Army is pushing hard to go ahead with a $6 billion program to produce and install its Nike-Zeus anti-missile system while USAF believes considerably more basic research and a more sophisticated approach to the missile defense problems are required. Main points under attack in the Nike-Zeus proposal is its inability to distinguish the genuine warhead from decoys, its inability to cope with a maneuvering warhead and its relatively short range.

NORAD is now using a combination of Nike Ajax and Hercules point defense missiles, most of them deployed around major population centers but some scheduled for use near SAC bases; a mixed bag of interceptors including the Northrop F-89, Convair F-102 all-weather interceptors and Lockheed F-104 day fighters and an early warning network beginning with the DEW, mid-Canada and Pinetree radar lines and extending out on both flanks with Texas tower radars in the Atlantic and new installations along the Aleutian chain plus airborne early warning aircraft of both USAF and Navy on patrol in the North Atlantic and Pacific.

Convair F-106 Mach 2 all-weather interceptor armed with nuclear air-to-air missiles is scheduled to go into service with NORAD during 1959. North American F-108 Mach 3 interceptor is under development as a long-range (1,000 mi.) interceptor to complement future air defense missiles.

Bomarc, which is going into service as a 200 mi. range missile, is being developed to an eventual range of 400 mi. and will be used in Canada as well as the U. S.

The twin crises of 1958 in Lebanon and Quemoy threw a sharp spotlight on the limitations of Tactical Air Command's current equipment in functioning as an international fire brigade to handle brush fire wars. Only small token forces of TAC combat planes were able to make the long emergency movements from U. S. bases to Turkey and Formosa in time to add significant weight to military forces in those areas. No complete combat units that started these airborne movements arrived in the potential combat areas anywhere close to normal fighting strength.

TAC now depends upon North American F-100Fs, McDonnell RF-101s, Douglas B-66s and Lockheed F-104s, all of which are capable of delivering nuclear bomb loads for its striking power, while logistic support comes largely from Lockheed C-130 and Douglas C-124 cargo transports.

TAC urgently needs a strong development program in the VTOL area to meet its future requirements plus a long-range turboprop transport to complement the medium-range operations of the C-130 and an allocation of KC-135 jet tankers to replace its obsolete KB-50 and KC-97 piston-engine tankers on which its aerial refueling operations for its supersonic fighters now depend.

TACTICAL AIR COMMAND LOCKHEED F-104C STARFIGHTERS

CHANCE VOUGHT F8U-1s of VF-211 approach the landing break above their home carrier, the USS Midway. Douglas A3Ds are visible

Navy Stresses Simplicity, Reliability to

By Cecil Brownlow

Washington—Navy, crimped within the restraints of the Administration's Fiscal 1960 balance-the-budget policy, is spending its dollars cautiously—and in many instances thinly—in an effort to maintain a strategic capability for all-out nuclear war and a tactical capability for limited war.

Within the tight-dollar framework that allows Navy a total of 688 new aircraft for the fiscal year, major emphasis is being placed upon development of the offensive Polaris fleet ballistic missile and an effective defense against missile-bearing, nuclear-powered Soviet submarines. In an effort to stretch the dollar as far as possible in these two areas and others, Navy planners and contract officials will place increasing emphasis upon simplicity of design and reliability of equipment.

Vice Adm. R. B. Pirie, Deputy Chief of Naval Operations for Air, recently warned contractors that, in future Navy design competitions, "the manufacturer with the reputation for making it work reliably will have the definite edge. We aim to concentrate our spending with those who can design and deliver. . . . the least sophisticated gear that will do the job."

At least one contract—for the Grumman A2F-1 low-level subsonic attack aircraft—already has been let providing incentive payments for reliability, performance and cost control.

This contract policy probably will be carried over to the Missileer competition scheduled for later this year by Bureau of Aeronautics for procurement of an aircraft to serve as a platform for the Eagle long-range air-to-air missile.

To shave costs and time, Navy may select an aircraft already in existence if it can find one that will do the job, rather than call for a completely new aircraft.

The Missileer-Eagle project was one of the major programs Navy managed to salvage despite early insistence by Defense Department fiscal planners that the project be scrapped in favor of the Air Force-Hughes GAR-9 system already under development for the North American Mach 3 F-108 interceptor. Navy contention, which finally won out, was that the GAR-9, incorporating semiactive radar guidance requiring the interceptor to keep its radar aimed at a target until the missile strikes, fails to fit into the Missileer "slow-plane" concept.

Missileer-Eagle plan envisions the use of a large, relatively slow aircraft capable of carrying a large number of missiles and with the ability of attacking a number of targets simultaneously through the use of an active radar guidance system.

Winning its fight after several months of debate, Navy in December awarded a prime contract for the Eagle to the Bendix Systems Division, of Ann

on deck as are North American FJ Furies.

Ease Budget Pinch

Arbor, Mich. Bendix Pacific Division had cognizance over guidance and control; Grumman Aircraft Engineering Corp. will build the airframe. Aerojet-General probably will be picked to develop the Eagle engine.

Interim guidance within the aircraft itself initially will be North American Autonetics Division's ATQ75, but the radar scheduled for later models of the missile will be a Westinghouse development. Eagle terminal guidance is being developed by Sanders Associates, Nashua, N. H.

Navy plans to spend $7 million on development of the Eagle during the first year, $8 million in the second, $10 million in the third, $14 million in the fourth and about $60 million in the fifth, which would include production.

In its over-all planning for future aircraft weapon systems, the Navy will depend more and more upon the "slow-plane" concept such as that envisioned for the Missileer for defense systems and rely upon the relatively more expensive high-Mach-number aircraft almost exclusively for attack missions where the planes must be capable of effectively contending with enemy interceptors. Adm. Pirie, in explaining Navy's thinking behind the "slow-plane" concept, says:

". . . Aside from the technological and cost problems, the very high Mach interceptor armed with a short-range missile is faced with an almost unsolvable intercept problem by virtue of the high speeds and short time involved. To provide for the necessary time for solution of the problem, it is readily apparent that the next interceptor weapons system development must include the capability of acquiring the target at extended range.

"This, in turn, dictates an airborne interceptor missile with increased speed and range performance. Add to this the ability of the missile fighter to track more than one target and the missile simultaneously and you have the basic ingredients of our follow-on interceptor concept.

"When it comes to task force defense, however, we have been considering another concept. With radar and missile development what it is, why must we bore supersonic holes in the air for air defense?"

So far as high-speed attack aircraft are concerned, Navy officials say present and planned angle-deck carriers probably will be capable of handling aircraft with speeds of up to Mach 4. Here too, however, Navy tends to favor the simpler, less expensive slow plane wherever possible.

A2F Concept

The A2F program, for example, envisions use of a twin-turbojet attack aircraft capable of maintaining a speed of Mach .9 in low-level flights designed to slip beneath a potential enemy's radar defenses.

The two-place A2F, with side-by-side seating, went into mockup last October. Aircraft reportedly has excellent accessibility from the ground to the large stores of avionic gear in the fuselage. There are no provisions, however, for getting from the cockpit to the avonic equipment while the plane is in actual flight.

Tight fund situation also is pushing Navy into a new look at its VTOL and STOL programs, with emphasis shifting to the latter—again because the system holds promise of producing simpler, less expensive aircraft. First operational STOL aircraft Navy will send to the fleet probably will stem from a follow-on project to the Grumman S2F search plane. Through use of STOL aircraft, Bureau of Aeronautics planners eventually hope to virtually eliminate the present, not exactly fail-safe, carrier catapults and arresting gear.

In the VTOL area, Navy will pull out of the Bell D-188A Mach 2 program within the next few months after the aircraft reaches mockup stage. Air Force, however, is continuing its interest in the project under the designation of F-109.

Nuclear-Plane Hopes

Administration fiscal planners and Navy officials also are clashing head-on on the latter's hopes for conversion of three British Princess flying boats to nuclear power. Navy admits that such an aircraft would be slow, probably cumbersome and have limited altitude capabilities. They contend, however, that such an aircraft could make an important contribution in providing the knowledge necessary before the all-new high performance nuclear weapon system the administration is insisting upon can be effectively designed and put into production.

Navy conversion program for the Princess would evolve around the Pratt & Whitney J91 nuclear powerplants. The two inboard engines of the six-engine Princess would be removed, and

MARTIN'S SIX YP6M SEAMASTERS

two J91 powerplants installed on top of the fuselage adjacent to the fuselage. The reactor would be located inside the fuselage directly beneath the wing.

The four remaining conventional engines on the Princess could be used for takeoff and landing to minimize the radiation hazard for ground personnel, cutting in the nuclear powerplants only after the aircraft was airborne.

Navy still hopes to get a go-ahead for the program but, for the moment at least, the concept has little support within the Administration.

Another budget-imposed disappointment for the Navy was the cancellation of the Chance Vought Regulus II missile program. Over bitter protests from the Navy, the 1,000-mi.-range Regulus II air-breathing missile program was terminated in December at the expiration of existing contracts and at a time when the development program was virtually complete. Cancellation of the project left the Navy with two submarines equipped to handle the Regulus II—the conventional Grayback and the nuclear-powered Halibut—and a total of 75 missiles. The submarines will now use the slower, 500-mi. Regulus I, of which the Navy has approximately 250. Once these have been exhausted, the submarines will be converted to other type missiles, probably the Subroc underwater-to-air-to-underwater anti-submarine system.

Another Navy program which barely escaped the budget slash was the North American A3J-1 Mach 2 attack bomber scheduled to replace the Douglas A3D-2 in the fleet in 1961. A BuAer spokesman said the status of the A3J "is often fuzzy" because of the high cost of the weapon system but that, for the present, "its still in the program."

Navy Aircraft on Order—1959

COMPANY	PLANE	NAME
	FIGHTERS	
Chance Vought	F8U-1P	Crusader
	F8U-2N	Crusader
McDonnell	F3H-2N	Demon
	F4H-1	
	ATTACK	
Douglas	A3D-2N	Skywarrior
	A3D-2Q	
Grumman	A2F	
North American	A3J-1	Vigilante
	PATROL	
Grumman	S2F-3	
	W2F	
Lockheed	P2V-7	Neptune
	P3V	
Martin	P5M-2	Marlin
	P6M-2	SeaMaster
	TANKERS	
Lockheed	GV-1	
	TRAINERS	
North American	T2J-1	
	HELICOPTERS	
Gyrodyne	DSN-1	
	DSN-2	
Kaman	HU2K-1	
Sikorsky	HSS-2	
	HUS-1	
	HSS-1N	
	BLIMPS	
Goodyear	ZPG-3W	

SeaMaster Cut

Fiscal limits and a lag in the development schedule also has led to a cut in Navy's order for the Martin P6M SeaMaster jet-powered seaplane from 24 to 14—six YP6Ms powered by Allison J71 turbojet engines, which already have been delivered (above), and eight P6M-2s powered by Pratt & Whitney J75s.

The six YP6M aircraft probably will be retained at the Patuxent River, Md., Naval Air Test Center for evaluation and test purposes; the eight P6M aircraft will operate as an operational anti-submarine warfare squadron, carrying both detection gear and weapons, probably including the ASROC rocket-

launced depth charge when, and if, its development program is completed.

Other recent terminations by Navy include the RAT (Rocket Assisted Torpedo) canceled early this year after a five-year development program by Bureau of Ordnance because of superior anti-submarine weapons now being designed, and the Douglas F4D fighter. The last F4D rolled from the Douglas production line earlier this year, and no replacement by Navy has been indicated.

Chance Vought was crippled in December by two decisions, cancellation of the Regulus II and the Navy selection of the McDonnell F4H-1 over the Chance Vought F8U-3 in the all-weather fighter competition.

The F4H-1, although in the Mach 2-plus speed range, fits into Navy's "slow plane" concept in that it has a greater range and on-station capability than the F8U-3. The F4H, scheduled to become operational in the early 1960s, is powered by two General Electric J79 engines and has provisions for a radar operator. The faster, but lower endurance F8U-3 is powered by a single Pratt & Whitney J75 plus a small rocket engine for maximum performance.

Over-all, Navy's Fiscal 1960 budget requests now before Congress include $1.725 billion in new money for aircraft; $645 million for missiles. At the end of the fiscal year, Navy expects to have an active aircraft inventory of approximately 9,100 planes—down 400 from Fiscal 1959—including 16 carrier air groups, 22 carrier anti-submarine warfare squadrons, 42 patrol and early warning squadrons and three Marine air wings. Along with the A2F, A3J and F4H-1, Navy's Fiscal 1960 aircraft budget includes funds for:

- **Douglas A4D-2N** all-weather version of the A4D powered by a 7,200-lb. thrust Curtiss-Wright J65 engine.
- **Chance Vought F8U-2N**, an improved version of the F8U incorporating a "limited" all-weather capability and a top speed approaching Mach 2. Pratt & Whitney J57-P-20 turbojet engine plus afterburner will give the F8U-2N a thrust of well above 17,000 lb.
- **Douglas A3D-2N**, an advanced version of the A3D attack bomber, which incorporates a cambered leading edge for improved high speed buffet conditions and increased combat ceiling and combat radius. Powerplants for the twin-engine bomber are 10,000-lb. thrust Pratt & Whitney J57-P-10 turbojets.
- **Grumman S2F-3**, an improved version of the S2F carrier-based submarine hunter-killer with advanced detection gear, is scheduled to reach the fleet sometime this year. The Tracker series is powered by twin Curtiss-Wright R1820 piston engines.
- **Grumman W2F-1**, a replacement for the WF-2 Tracer as an early warning aircraft. Powered by two Allison turboprop engines, the W2F-1 will operate off carriers, have considerably greater range than the Tracer.
- **Lockheed P2V-7**. Navy is continuing purchase of this aircraft—the -1 version appeared shortly after World War II—as an interim measure until a more advanced land-based ASW search-and-kill aircraft can be brought to operational status.
- **Lockheed P3V**, an Electra turboprop transport converted for use as a possible replacement for the P2V. Navy this year is buying small quantities of the converted aircraft for evaluation.
- **Lockheed GV-1**, tanker version of the Air Force C-130 Hercules, is being procured in small quantities for the Marine Corps.

Only trainer Navy plans to purchase during the coming year is the North American T2J-1 powered by a 3,400-lb. thrust Westinghouse J34-WE-46 turbojet engine. The Temco TT-1 jet trainers purchased by Navy are still in the process of evaluation, but Bureau of Aeronautics officials say the present version, powered by a 920-lb. thrust Continental J69, is underpowered and that its future appears dim unless its power rating can be improved.

Missile Procurement

In the airborne missile field, major share of Navy's development funds are scheduled to go to the Eagle and to the Temco Corvus 75-mi. range air-to-surface missile scheduled for use aboard turbine powered attack aircraft. Air-to-air interceptor missiles planned for the interim before the Eagle reaches operational status include an advanced version of the Sidewinder, designated Sarah, and the Sparrow III.

The Sparrow III, under development by Raytheon Manufacturing Co., uses a semiactive radar guidance system directed by radar impulses transmitted from the launching aircraft and reflected from the target. This system will allow the Sparrow III to attack targets from any direction and from any side angle plus targets several thousand feet above or below the attacking aircraft.

In the short-range air-to-ground field, Navy's Martin Bullpup missile guided

Navy Planes on Hand

(End of Fiscal Year)

1957	11,617
1958	10,654
1959	9,500*
1960	9,100*

*Planned

RAYTHEON Sparrow III is fired from McDonnell F3H Demon.

by voice command is scheduled to become operational with fleet units and the Marines later this year. Propellant for the Mach 2 missile is manufactured by Allegany Ballistics Laboratory.

Surface-to-air missiles scheduled for procurement during the coming year for shipboard use include the improved version of the Convair Terrier, the smaller Convair Tartar and the Bendix Talos. Marine Corps also plans to procure the Army-Raytheon Hawk low-altitude anti-aircraft missile.

The two areas in which Navy is receiving additional funds—although, it feels, not enough to meet its needs—are the Polaris fleet ballistic missile project and the recently-vitalized anti-submarine warfare program.

First operational Polaris, designated the AP-1 and with a range of slightly more than 1,200 mi., is scheduled to be fired from the Air Force Missile Test Center, Cape Canaveral, Fla., in the spring of 1960 and go aboard the first Polaris submarine, the George Washington, in the fall of the same year. An initial operational capability may be attained by late 1960 or early 1961.

Follow-on developments now in the planning stage include boosting the specific impulse of the Polaris solid-propellant powerplants to increase the missile's range to 3,700 mi. and placing the weapon aboard surface ships, probably converted cruisers. Designation of the 3,700-mi. Polaris will be AP-2.

Congress already has approved appropriations for nine Polaris nuclear powered submarines, each of which will be capable of carrying 16 missiles. Thus far, the Administration has released funds for the construction of five.

Navy's anti-submarine warfare programs, its deficiencies hidden from public view for years, is now being expanded in the face of a threat from Soviet missile submarines. Adm. Arleigh Burke, Chief of Naval Operations, said in the spring of 1958 that the Soviet navy at that time was believed to have three-to-four submarines equipped with air breathing missiles similar to the 500-mi. range Regulus 1. More recently, he said: "I think they could have ballistic submarines now. I do not think they have very many."

Most top Navy officials in the anti-submarine warfare program believe that the Soviets' submarine-launched missile capability at the moment rests entirely upon air-breathing weapons and that these systems are not yet operational. They say, however, that both the air-breathing and ballistic missile potential of the Russians in this field has reached the point where they can be rapidly expanded.

NORTH AMERICAN A3J

NORTH AMERICAN T2J

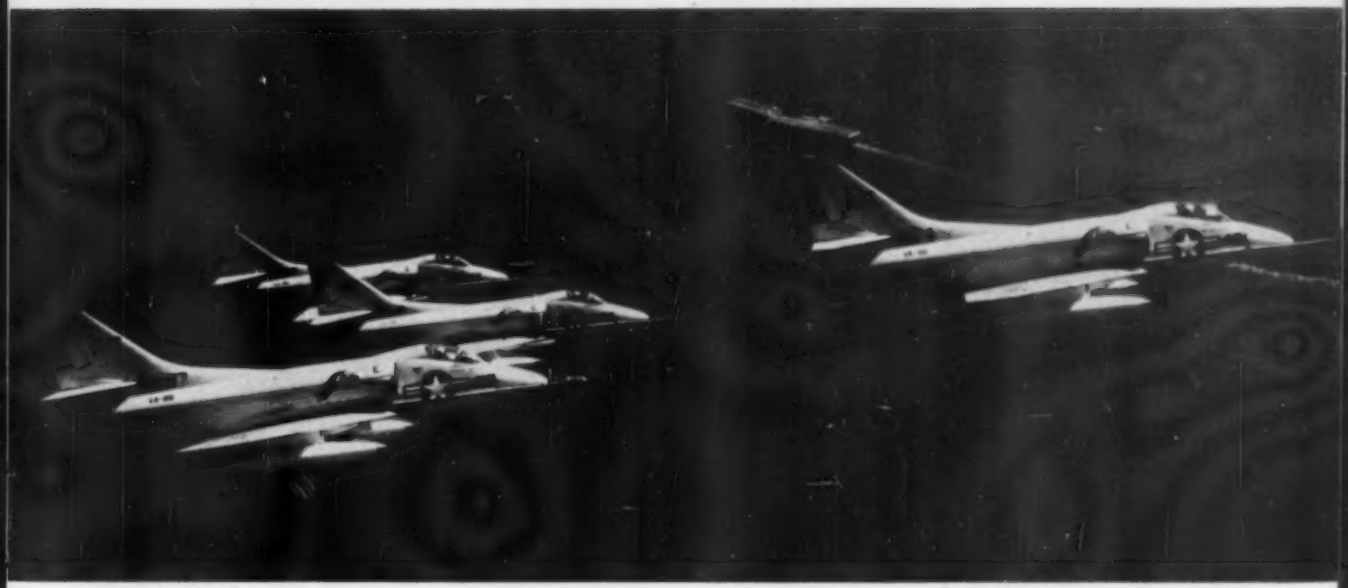
Intelligence Estimates

U.S. intelligence estimates of the Soviet submarine fleet report that it apparently has declined from 464 vessels last June to 450 today. As yet, there is no positive information that the Russians actually have nuclear-powered submarines in hand, but Rear Adm. John S. Thach, commander of Task Force ALFA which has been given the task of improving the present ASW technology, believes the force is going through a transition period, with the Soviets retraining crews and building new submarines to attain an all-nuclear, missile-equipped fleet.

Adm. Thach estimates that a dozen Soviet Polaris-type submarines could destroy 70% of the U.S. economy in a single blow. The capability of present U.S. equipment to detect and classify a deep-running, fast nuclear submarine is dangerously small.

In an attempt to improve its capability, Navy is seeking across-the-board help from U.S. industry and pushing its own bureaus to try and provide better technology and techniques.

"They've told us," a Bureau of Aeronautics official says, "that anti-submarine warfare is our main concern,



DOUGLAS A4D BUDDY REFUELING

and so we're trying to get an ASW capability out of everything we have."

Along with its evaluation contract for the land-based Lockheed P3V, Navy also is planning within the near future a design competition for an ASW search-and-kill seaplane as a replacement for the venerable Martin P5M. Design criteria Navy plans to impose may be difficult to meet—smaller in size than the P5M but capable of greater endurance, range and payload.

In an effort to maintain its force of largely World War II destroyers as an effective weapon against the faster nuclear submarine, Navy also is looking toward the use of drone helicopters to compensate for the surface vessel's deficient speed.

Evaluation contracts have been awarded to Gyrodyne for two drone helicopters—the single-engine DSN-1 and the twin-engine DSN-2—for possible use aboard destroyers. Under present plans, Navy would rely upon the relatively sophisticated detection gear of the destroyer to detect and classify the submarine and then launch the helicopter carrying a small torpedo to make the final kill.

Gyrodyne Evaluation

Installation of a heliport and hangar aboard a prototype destroyer, the Hezelwood, is scheduled to begin within the next few weeks to aid in the evaluation program of the Gyrodyne and other drones.

Seriousness of Navy's concern over the threat of Soviet submarines, both as a tactical weapon in its ability to harass shipping and as a strategic weapon to launch missile attacks against the U.S., was outlined last week by Adm. Jerauld Wright, commander of the U.S. Atlantic Fleet and supreme allied commander in the Atlantic.

Adm. Wright estimated that between 80 and 90% of the Atlantic Fleet has the primary mission of destroying the Soviet submarine in case of war.

This includes almost all of the fleet's attack aircraft which have been given the assignment of striking at the Soviet mainland in the event of war. Their first objective—to hit the Russian submarines in their home ports.

GRUMMAN F11F TIGERS OF VF-21

VERTOL MODEL 107, prototype of the Army YHC-1, can carry the Honest John surface-to-surface missile. Army's YHC-1s will have provision for 22 troop seats plus troop commander or 15 litters plus two medical attendants. They will carry up to two and a half tons of cargo.

Army Waits for Tactical VTOL Aircraft

REPUBLIC SD-3 combat surveillance drone is designed to be JATO-launched from Army trailer.

By J. S. Butz, Jr.

Washington—Hopes of equipping Army units with high speed STOL and VTOL aircraft needed to provide adequate reconnaissance and transport capabilities in an atomic war are still several years away even if the necessary financing is made available.

Five of the Army's stable of six VTOL aircraft are undergoing flight testing by their manufacturers and soon will be tested as a group by the National Aeronautics and Space Administration. STOL aircraft are much closer to quantity production.

The first Grumman AO-1 Mohawk, a high speed STOL reconnaissance aircraft, is scheduled to fly sometime this spring. Six de Havilland Caribous are being built for evaluation by the Canadian and U.S. Army. First Bell HU-1 Iroquois turbine powered helicopter using a Lycoming T53 engine is in use and the Army is impressed with the economy and ease of operation that this type of powerplant appears to be capable of providing.

Further in the future the Army will be evaluating three different models of flying jeeps all using the ducted fan principle. Chrysler, Piasecki and Aerophysics are developing these aircraft. Another more revolutionary design development is being financed by the Army and Air Force jointly and is in progress at Avro Aircraft. This is the flying saucer which uses an annular jet

to provide it with vertical rising ability. This annular jet theoretically and in small scale investigations has been shown to have the potential of increasing the available lift of an aircraft a hundred times or more when it is operating within ground effect. The lift increase realized by a conventional aircraft or helicopter is only about 15 to 25% when it enters ground effect. This type of aircraft also has a great speed potential in level flight.

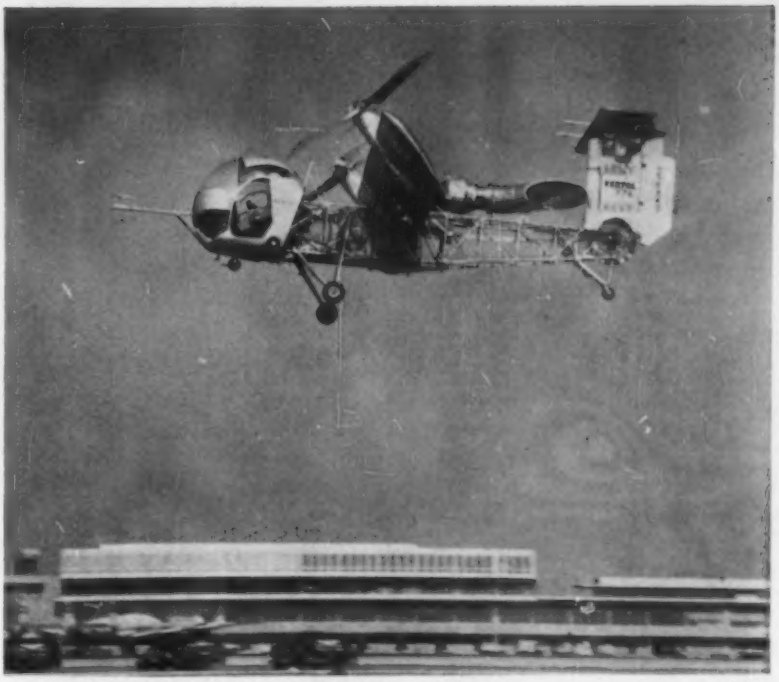
Increased Performance

In general the Army is very pleased with the progress that is being made with its new aircraft that are flying or soon will be. They all have a substantially better performance than the equipment now operating. The de Havilland Caribou STOL transport, for instance, will carry as much as a DC-3 or about eight tons, which is several times the payload of the Otters and Beavers now being used by the Army, yet it has approximately the same take-off capabilities under full load. The Caribou will get off most fields and over a 50 ft. obstacle, depending on the type of surface, within 1,000 ft. Two Pratt & Whitney 1,450 hp. R2000 engines power the Caribou.

The Grumman Mohawk has about the same power loading as an F8F fighter and will provide the Army with a several fold increase in the performance of observation aircraft. A program has already been completed to outline as much as possible the necessary equipment, procedures, flight patterns, etc., needed to gather reconnaissance information from a low flying aircraft at about 300 mph. or better. This program made use of several Cessna T-37 trainers on loan from the Air Force to see just how much a human observer could see when passing rapidly over all types of terrain. Some automatic equipment was also tested. Much more work will have to be done when the Mohawk is first put through a tactical evaluation but enough has been done to find that the aircraft will be very valuable even with its electronic equipment inoperative.

Engineering Evaluation

The Army's plan to turn its six VTOL testbeds over to NASA for an engineering evaluation is thought by some to be an inadequate approach to the whole problem of bringing effective tactical aircraft into being as soon as possible. While a great deal of engineering information will eventually land in the hands of the manufacturers and the Army after the NASA tests, no information will have been provided about the characteristics of the aircraft under combat conditions. There are many unknowns concerning field operations that may combine to make VTOL aircraft



VERTOL MODEL 76 makes transition to forward flight. Powerplant is Lycoming T53.

BELL XV-3, being developed for Army, flies with rotor masts in airplane configuration.

DOAK MODEL 16, designated the VZ-4DA by Army, is powered by ducted fans on wingtips.

WESTERN ELECTRIC NIKE HERCULES

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in their present form unusable by tactical units.

One of the principal questions is the dust situation. Helicopters raise a considerable amount of dust under certain ground and weather conditions. This not only presents a technical problem to keep the powerplant and the equipment in the helicopter functioning properly and from wearing out prematurely, but there is the all important factor of aiding enemy location of the grounded vehicle through the dust cloud. The ducted fans being used on many of the VTOL test beds and on the flying jeeps have a much higher velocity in the slipstreams below their blades than helicopters do and consequently increase the dust problem.

Other problems concerning the basic configuration of these aircraft probably will never be known until they are tested under conditions approaching service use.

Basic Weakness

One basic weakness of the Army's VTOL research is that money has been available to buy only one experimental vehicle of each design in most cases. The six designs:

- **Ryan VZ-3 and Fairchild VZ-5** which use the deflected slipstream principle.
- **Bell XV-3,** tilt-rotor.
- **Vertol VZ-2,** tilt wing.
- **Bell X-14,** deflected thrust, which is an Army project.
- **Doak VZ-4** rotatable ducted fan.

The Ryan VZ-3 crashed recently when making a conventional landing in the airplane configuration and the program will be held up for some time. The crash apparently was caused by a minor structural failure which prevented the pilot from making his flare. Complete loss of any of these VTOL aircraft during the tests could make a positive answer as to the best configuration unattainable for many years.

Research Questions

Another question of Army research policy which is not connected with finance is the direction and limitation which will be attached to research contracts with universities and industry. This is the same question which has plagued all of the services since they began buying research.

The Navy was perhaps the first service to approach research contracting in the manner most acceptable to the agencies performing the research. This is to set down only the most general requirements and specifications to describe the job that needs to be done, then leave the researcher free to approach it from any conceivable angle. The restrictions grow normally as the work moves from the basic research field

into the applied research area when operational requirements and logistical questions come into play.

The normal tendency has been for the research and development people to want a free hand to solve a problem in the best possible way and for the military commands to impose certain restrictions to keep from disrupting current training procedures and tactics and plans as little as possible. The Army is now undergoing a considerable strain trying to establish a definite policy which will satisfy its own demands as well as university and industrial contractors.

Engine Projects

Three turbine engine development programs are being funded by the Army and these programs are the heart of any STOL or VTOL plans at the moment. Only a major improvement in engines will allow a major improvement in these vehicles unless major changes in aerodynamic design approach such as the Avro saucer are followed. The engines are the Lycoming T53 of about 900 shp., the Allison T63 of about 250 shp. and weighing less than 100 lb. and the Lycoming T55 of 1,850 shp.

Helicopter and aircraft testing at accelerated rates is being performed by the Army as soon as possible. This has greatly helped the logistical problem of buying and supplying parts at the lowest possible cost. In the past it has not been possible to get much flying time on Army equipment in normal service use for two or three years. It was thus necessary to purchase parts based on engineering estimates of what part life would be. This proved to be several hundred per cent incorrect as many times as not. Present test programs, which put as much time on the new equipment in six months as was possible before in three years, plus greater engineering experience, have combined to reduce this problem and lower the expense of operating large numbers of aircraft.

Army last week announced it is negotiating with Vertol for design and development of the YHC-1-B two- to three-ton helicopter. Choice has been under discussion for a year or more. The primary trouble has been financial, as has been the case in development of a flying crane for rapid movement of heavy equipment.

Apparently Army research on aerial vehicles had tended more toward the VTOL principle than the STOL. No strictly STOL research craft have been built and no large program to provide instrumentation to facilitate very slow flight has been pursued. Needed equipment would include new airspeed indicators functioning at speeds of 30 mph. and below, stall warning devices and attitude indicators.

Will Available COMPONENTS Keep Pace With SPACE AGE PROGRESS?

Systems designers have done a phenomenal job of advancing the state of the art in missile and space effort. Through necessity, the lack of suitable components has been compensated for by the use of redundency and other compromises. Eventually, however, the rapid advance in systems development may stall as its capabilities outstrip the potential of the individual components.

Let us not permit this situation to develop.

Many components manufacturers have, because of lack of adequate research and development funds, stretched their resources to a dangerous limit to meet these needs. We do not believe that this is enough. Means must be found whereby some of the Research & Development funds, being spent by the Military and Prime Contractors, is funneled down to component manufactures (specialists in their fields) in order to assure that components keep pace with systems development.

If this is done, there will be no practical limit to the advances which will result.

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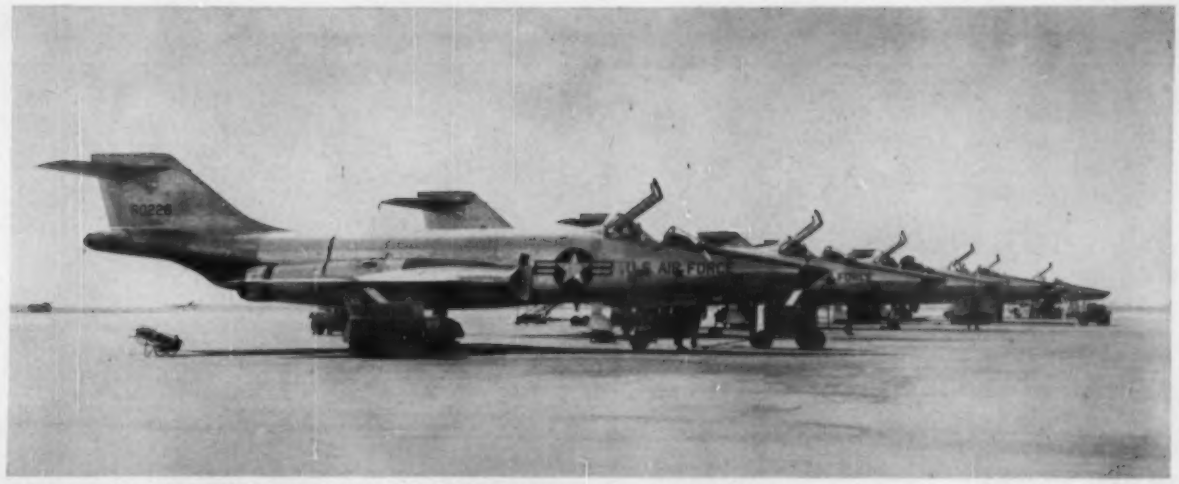


LINE of McDonnell RF-101Cs of the 38th Tactical Reconnaissance Squadron at Phalsbourg Air Base, France. The 38th was the first USAF unit to receive the Voodoos, which came into Europe late in 1958.

German 'Disengagement' Is Crisis to NATO

Paris—NATO's "forward line" in western Europe will be under heavy fire during the scheduled East-West negotiations over the political future of Germany—if they take place.

Many observers here, both political and military, feel the Soviet Union may dramatically bargain away its political position in East Germany if, in return, it can neutralize NATO's growing nuclear build-up in West Germany. Yet with few exceptions NATO strategists say any agreement forbidding nuclear capability in West Germany would cripple NATO's whole military posture in western Europe.

"The next step," remarks one top U. S. military officer, "would be for us to pick up our marbles and go home."

Current planning at Supreme Headquarters, Allied Powers, Europe (Shape) assumes considerable build-up of atomic delivery capability among NATO "shield forces" in West Germany. By 1963, for example, NATO ground forces in Europe will include 100 rocket and missile battalions instead of the present 30.

Bulk of these 30 battalions are mainly U. S., plus some British units. Dual-capability weapons currently in the field are mostly Corporal and Honest John rockets and several squadrons of USAF Martin Matadors. But by 1963, Shape planners expect considerable numbers of Sergeants, Martin Maces and perhaps Martin Pershing tactical missiles also to be in the field.

German Problem

Almost all of these dual-capability rockets and missiles are to be deployed in West Germany. Thus any negotiated "disengagement" agreement on the German question which would forbid—or even limit—this buildup, necessarily would require a complete overhaul of Shape's mission.

In fact, many Shape officers say in private that any disengagement agreement implies the end of Shape's mission in west Europe. It has taken Shape 10 years, they argue, to achieve its fairly efficient though still unsatisfactory supply and communications systems, and "you just don't disengage and start all over again."

Others claim the Western Alliance, under a disengagement formula, would lose Shape's growing contribution to its over-all nuclear deterrent at a time when Russian missile superiority appears most evident.

Shape's current drive to build its nuclear capability stems directly from decions taken by the 15-member NATO Council in December, 1957. Initial implementation got under way during 1958. The two most important decisions were agreement in principle to set up some intermediate range ballistic missile bases within the NATO area and, secondly, the establishment of a NATO atomic stockpile for allied use.

NATO atomic stockpile: this project means establishment of "warhead supply depots" near the NATO delivery vehicle, be it aircraft or missile. Control over the nuclear warhead remains in the hands of Shape Supreme Commander Gen. Lauris Norstad, no matter what the nationality of the delivery vehicle. Before the establishment of NATO's atomic stockpile, atomic warheads were available only to U. S. forces. But under the new system, for example, Danish F-100s as well as USAF F-100 units will have access to nuclear weapons if Shape has the requirement.

1958 Progress

While no precise information on NATO's atomic stockpile is available Shape officers appear to be satisfied with progress made in 1958.

NATO IRBM bases: progress on this project during 1958 has been confused by internal political situations in the NATO nations involved. France, for example, even before Gen. Charles de Gaulle came into power, refused to accept IRBM bases unless Paris controlled their use. That the British were willing to accept four Thor IRBM squadrons under joint-control with the U. S.—under an agreement which preceded the NATO 1957 decision—doesn't impress the French. They argue that Britain can afford to enter into joint-control arrangements with the U. S. since it already has independent atomic capability. But since France hasn't yet achieved this, Paris feels it must have complete control or keep clear of the whole project. Shape would like to see at least two Thor or Jupiter squadrons in France, but the prospect looks dim.

Elsewhere, the going has been somewhat smoother. Bilateral IRBM agreements between the U. S. and Italy, Greece and Turkey are well along, although any thaw in the cold war might change the whole outlook. Shape Commander Gen. Norstad wants two Jupiter squadrons in northern Italy and one

CONVAIR TF-102A touches down at Bitburg, Germany. TF-102As will replace F-86Ds of USAF's 525th squadron.

each in Greece and Turkey. Britain's four Thor squadrons are, of course, NATO-committed.

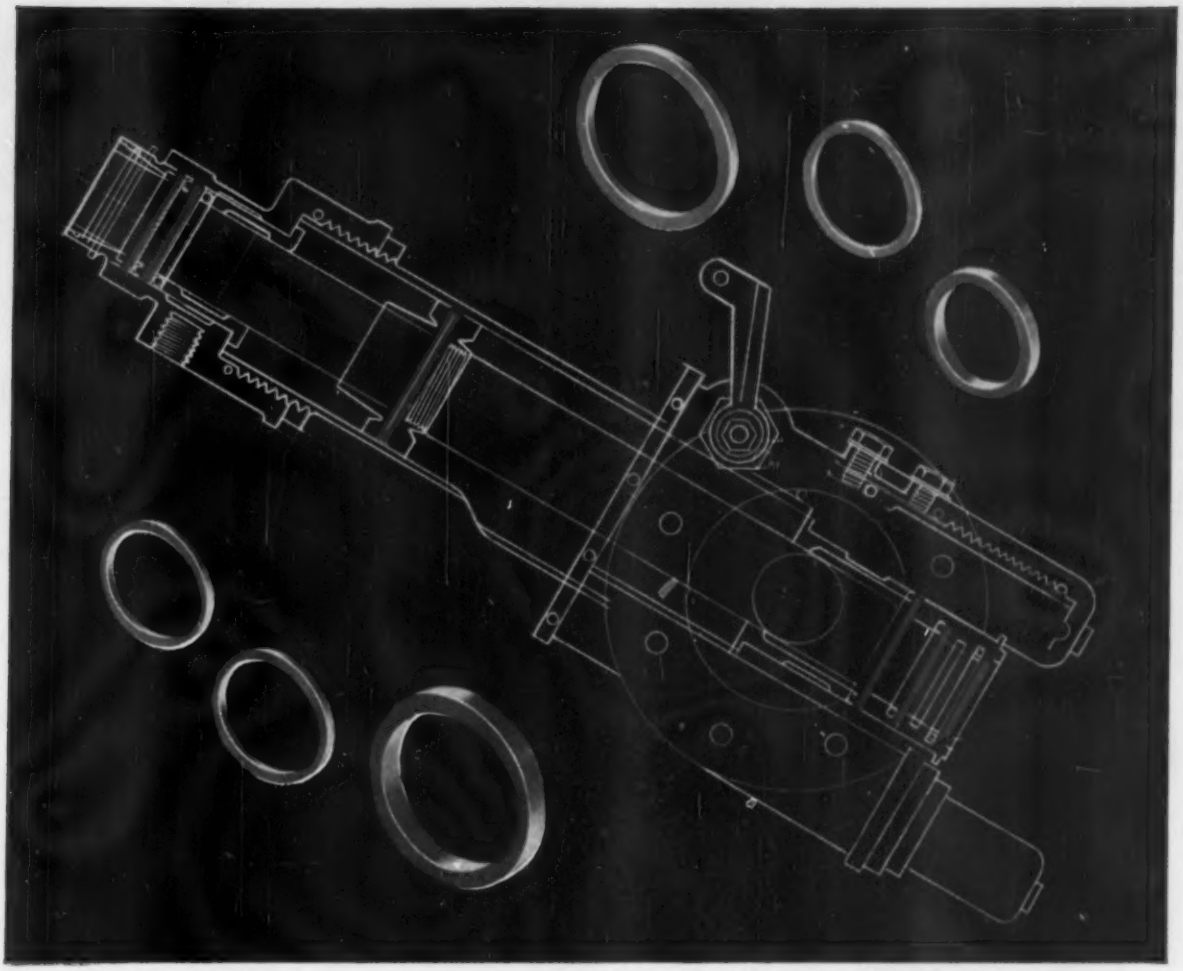
Shape officers, from Gen. Norstad on down, feel that their current nuclear build-up in no way alters Shape's basic mission in Europe, but rather helps to meet it. This mission is to oppose physically Soviet probing strength on the front line with adequate forces so that any Soviet move against this line will immediately involve military action. Size of the action would depend on the strength of Soviet probing forces. But in any case, according to Shape reasoning, by meeting force with force a "pause" in Soviet thinking would take place, during which time top Soviet leaders would have to make a conscious decision to bring up greater penetration force. Thus the Soviets would have to take into consideration all the forces and factors which make up the West's deterrent, including heavy strategic forces.

Failure to maintain adequate forces in the front line, Shape officers say, might invite a series of Soviet probes into NATO territory under a variety of pretexts. Once inside NATO's front line these Soviet forces might halt their advance before any military action had begun. This would then present NATO's 15 nations with the difficult political decision of launching military action to drive them back. "Failure to have such a force deployed in the forward line," Gen. Norstad insists, "would invite a series of incidents and would leave us with no warning and no response which was adequate to the event."

MOCKUP of Northrop N-156, lightweight, twin-jet fighter developed for NATO defense forces. The fighter is a version of the T-38 supersonic trainer.

Many military observers, while agreeing with Shape's interpretation of its European mission, feel that apart from U. S. units, plus certain highly-trained British outfits, Shape's "shield force," both land and air, is much weaker than it appears on paper. Many of the 19 to 23 claimed NATO divisions in Europe are not even on World War II standing as far as modern fighting capability is concerned. Many of the 5,000-6,000 NATO aircraft are either obsolescent or grounded for lack of trained ground and air crews. Large part of the trouble, these critics maintain, stems from the necessity of Shape to assume that NATO's 15 nation members can all achieve modern military establishments at roughly the same speed. Result is that Shape's effectiveness continues to rest largely on non-European forces.

While Shape officials publicly shy from this problem, their anxiety about its solution probably explains their current efforts to phase in as many advanced-type U. S. rockets and tactical missiles as U. S. and certain allied units



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can handle. The idea is not only to offset numerical strength of opposing Soviet forces, but to offset the lack of trained NATO units which make up the shield force.

With its missile build-up now under way, Shape planning calls for the reduction of about 30 to 40 air squadrons by 1963. On a qualitative basis Shape's smaller air force in 1963 should be a more effective fighting force than it is today. Emphasis is now being placed on all-weather equipment and aircraft designed—as in the case of the Fiat G.91 lightweight strike fighter—specifically for European conditions.

During late 1958 and early 1959, USAFE began phasing in McDonnell RF-101Cs and Convair F-102A all-weather interceptors. RAF 2nd Tactical Air Force in Germany during 1958 brought in additional squadrons of Gloster Javelin all-weather fighters. Main Canadian contribution to Allied Air Forces, Central Europe, remains as several squadrons of Avro CF-100s. French NATO air effort in Europe still is hampered by French air missions in Algeria.

German Luftwaffe, which currently consists—on paper—of two F-84F fighter-bomber wings and one Noratlas transport wing, will be in a training phase for the next several years. By 1963, however, German F-104 units should be operational.

Air Defense Integration

Integration of NATO air defense still remains a big problem for Shape air commanders, though more progress has been made in this area than is generally known. Actually, when Shape was first set up its Supreme Commander, Gen. Dwight D. Eisenhower, was specifically relieved of responsibility for air defense except in forward areas. But in 1955 Shape was directed to coordinate air defense throughout Europe.

Today all the countries involved in the scheme—except France—have agreed to integrate their air defenses under NATO. French reason for hanging back is more political than military, as is the case with its attitude toward IRBM bases.

On a practical level, air defense integration has made some progress. During 1958 Shape air commanders claim considerable work went toward the establishment of common rules of engagement and the creation of a standard data evaluation system. NATO's vast early warning system is now slated for completion by 1961. Also, within 18 months Shape's "forward scatter" communications system should be completely installed. First section, in Norway, went into operation last August. System when completed will give near jam-proof communications to NATO commands from Norway to Turkey.

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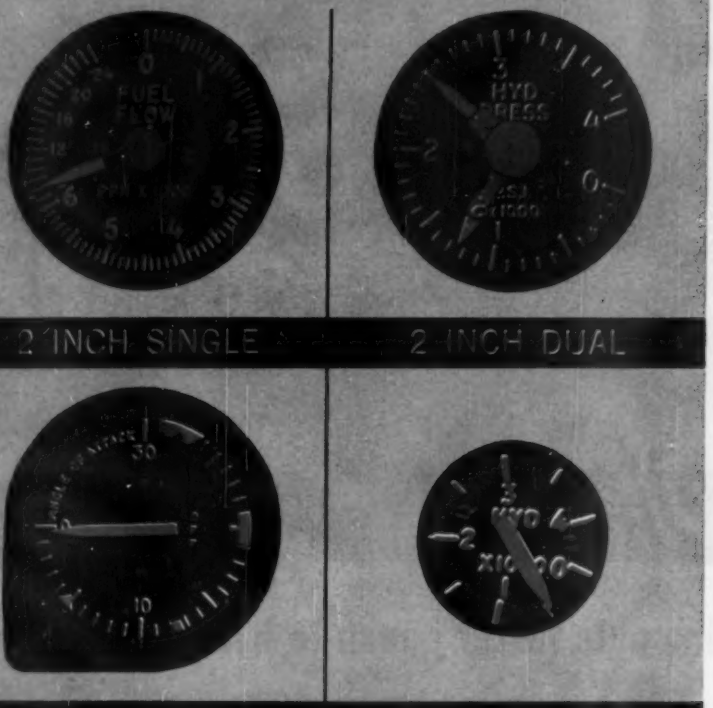

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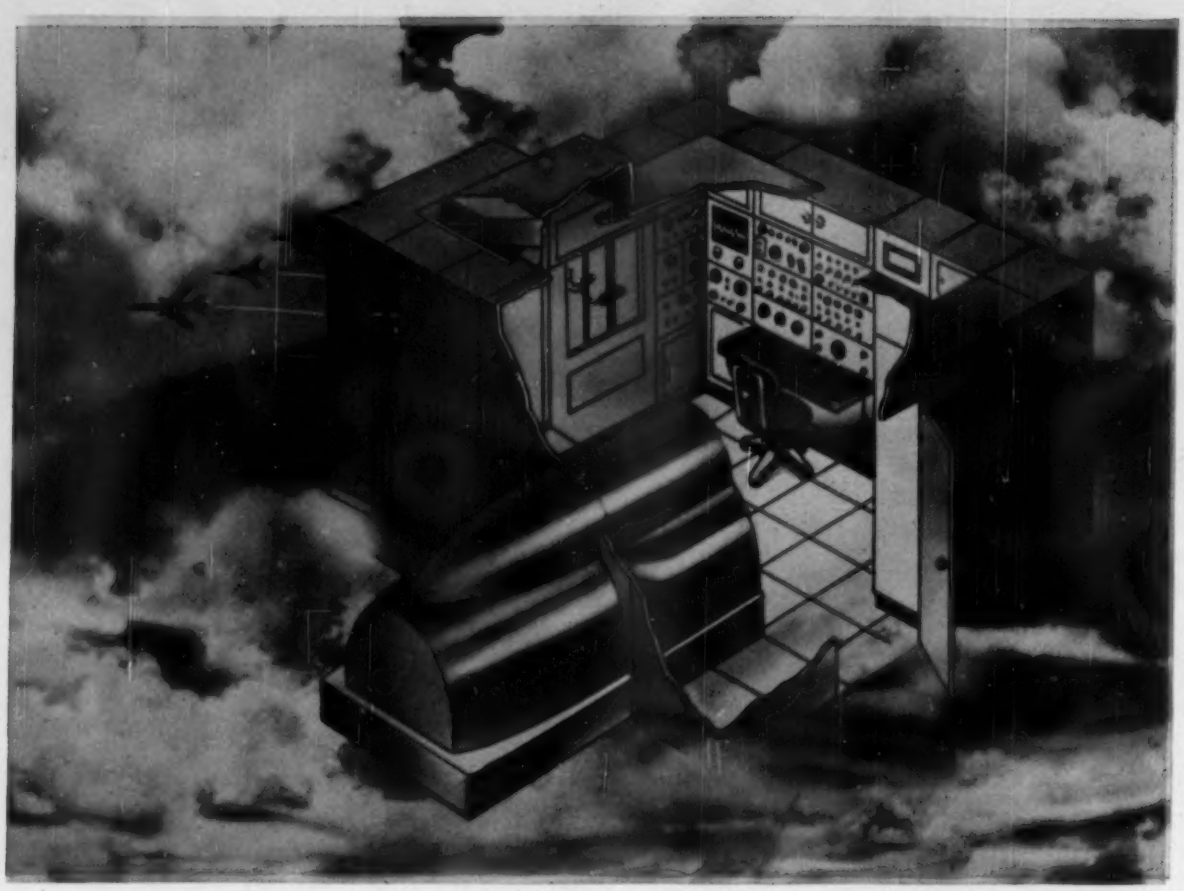

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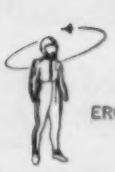

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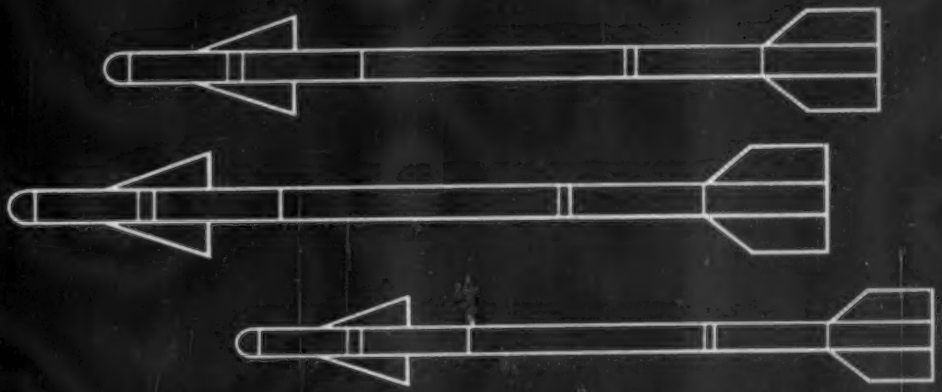

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U.S. Hammers Out Integrated Space Plan

By Evert Clark

Washington—Space exploration within the next year will involve the launching of 30 or more U.S. satellites and space probes to as far away as Venus, and the expenditure of almost a billion dollars.

Hardware that will make possible such ambitious missions as landing men on the moon and Mars and returning them to earth already is under development.

The reversal of attitude reflected in this great effort was forced by Soviet Russia's technological progress. It is being aided considerably by the emergence of missile boosters from the cocoons of research and development.

Although the prospect of surpassing the Russian competitor in the conquest of space still lies well in the future, the U. S. at last is on its way toward formation and execution of an integrated national space program.

Giant Barriers

The problems remaining are great—organization and administration, proper public support and funding, division of responsibility, and such formidable technical problems as reliability, development of long-life electronic components and life-support systems, and the vast amount of research involved in understanding navigational and communication techniques, orbital mechanics, and survival in a physical environment that already has proved to be unexpectedly hostile to man.

Government has responded to this challenge with the creation of two agencies—which some critics say are one too many—and financial support that is quite generous by pre-Sputnik standards but less generous than many of those in charge of its space programs would like.

Industry has responded by recognizing quickly the importance of this new field and the market involved. Companies have created new divisions or reorganized and reoriented old ones and have produced, often on extremely tight time schedules, the hardware necessary to take the first faltering steps into space.

A little more than a year ago the largest rocket engines in the U. S. were in the 150,000 lb. thrust category. The largest one for which anything like real development was under way was a 300,000 lb. thrust engine.

Booster Development

Now there are two development programs calling for boosters of 1.5 million lb. of thrust and one of these can be clustered to produce a booster with a thrust as high as 20 million lb.

Neither is at hand and ready for use. But propulsion is the key to the exploration of space, and these projects provide an excellent example of the shift in official thinking on the importance of this exploration.

Primary agency in the U. S. space effort is the National Aeronautics and Space Administration, created last spring around the 43-year-old National Advisory Committee for Aeronautics, and operational since last Oct. 1. This is now an organization of more than 8,000, with a Fiscal 1960 budget approximating half a billion dollars. NASA Chief T. Keith Glennan believes his budget may grow to $2 billion in another two years.

Although this growth from a $100 million a year research agency into a research, contracting and operating agency is not without its growing pains, NASA so far has had Presidential-level support, Congressional cooperation and reasonably good relations with other governmental agencies, considering that its mission requires it to take supervision—and funding—of projects and personnel away from them.

ARPA Funding

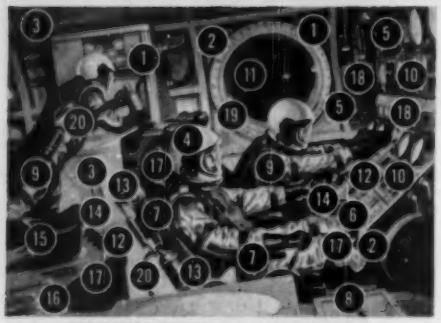
Military counterpart of NASA is Defense Department's Advanced Research Projects Agency. Created on Feb. 7, 1958, and operational since about last April, ARPA has asked $307 million for military astronautics in the fiscal year beginning next July.

ARPA initiated work on five lunar probes and several satellite projects that now have been passed to NASA. Other work on meteorological satellites and the Centaur high-energy upper stage rocket will pass to NASA's control on July 1.

In the astronautics field, this still will leave ARPA with supervision over the Discoverer series of satellites; a number of navigation and communication satellites, the first of which are to be launched this year; partnership in the NASA Mercury man in space project; development of a 1.5 million lb. thrust rocket engine cluster; the Sentry reconnaissance satellite project; the Midas early warning satellite, and other undisclosed work.

A new office that is expected to play an increasingly important role in space efforts is that of Director of Research and Engineering in the Defense Depart-

NASA'S JUNO II vehicle was used in the Pioneer III lunar shot. Developed by the Army Ballistic Missile Agency and using a Jupiter IRBM as booster and upper stages developed by the Jet Propulsion Laboratory, Juno II will be used for new space shots in 1959 and 1960. NASA expects to use at least eight of the vehicles.



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ment. Although its authority in relation to ARPA's space work and the supporting space work being done by the services still is not perfectly clear, its influence will be powerful. Headed by Dr. Herbert York, former chief scientist of ARPA, it reports to Defense Secretary Neil McElroy and has review power over all service research projects.

Best evidence that the U. S. is determined to make considerable progress in space technology in the future is the outline of proposed vehicles described to Congress recently by NASA officials. Some are cooperative NASA-ARPA projects. In roughly the order that they will become available, they are:

• **Project Scout**—A family of high performance, solid fuel rockets that can be clustered and grouped to send payloads of up to several hundred pounds into orbit or to altitudes up to 5,000 mi. (AW Feb. 2, p. 26).

• **Thor-Hustler**—This is the vehicle now being used in the ARPA-USAF Discoverer satellite series. Utilizing the Douglas Thor and the Bell Aircraft Corp. Hustler engines, it may eventually put up satellite loads as high as 10,000 lb. (AW Feb. 16, p. 30).

• **Atlas-Able**—Convair Atlas plus some or all of the upper stages now used with Thor-Able. These are an Aerojet-General 7,500-lb. thrust liquid propellant engine and an Allegany Ballistic Laboratory 2,500-lb. thrust solid engine.

• **Atlas-Hustler**—Atlas plus the Bell Hustler, which uses JP-4 and red fuming nitric acid. This vehicle could put at least 3,000 lb. into a 300 mi. orbit.

• **Vega**—Atlas first stage, a liquid oxygen and kerosene second stage, and a 6,000-lb. thrust, storable liquid third stage now being developed by NASA's Jet Propulsion Laboratory.

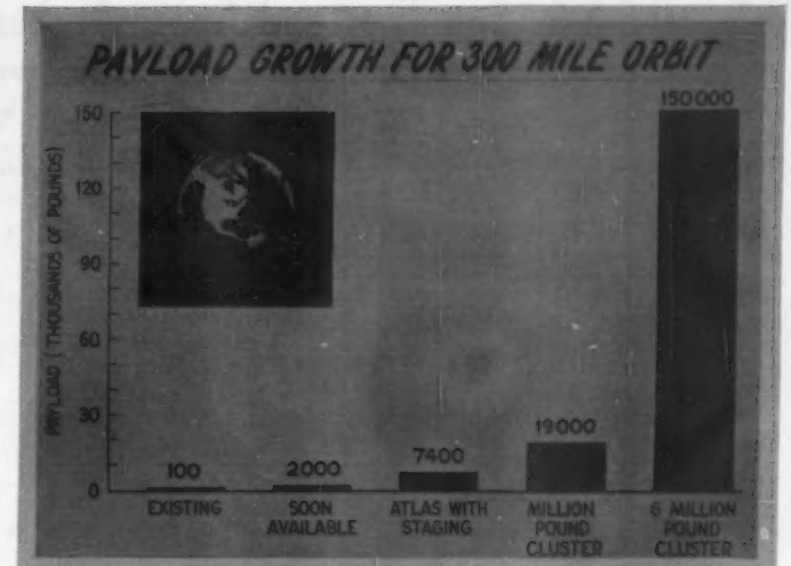
• **Centaur**—Modified Atlas first stage, liquid oxygen and hydrogen second stage, storable liquid third stage.

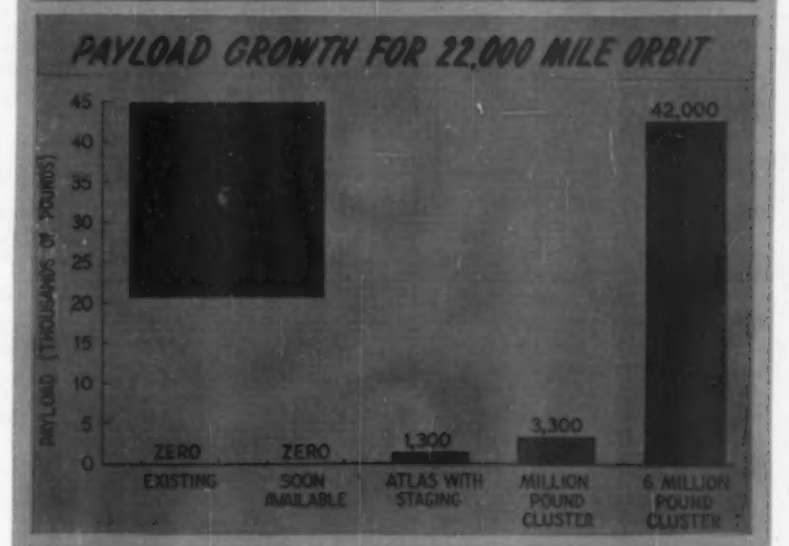
• **1.5-million lb. cluster** of eight 150,000-lb. (approx.) Rocketdyne engines being developed by Army Ballistic Missile Agency as a first stage; modified Martin Titan intercontinental missile booster as second stage, using liquid oxygen and kerosene; a lox-hydrogen third stage, and a storable fourth stage.

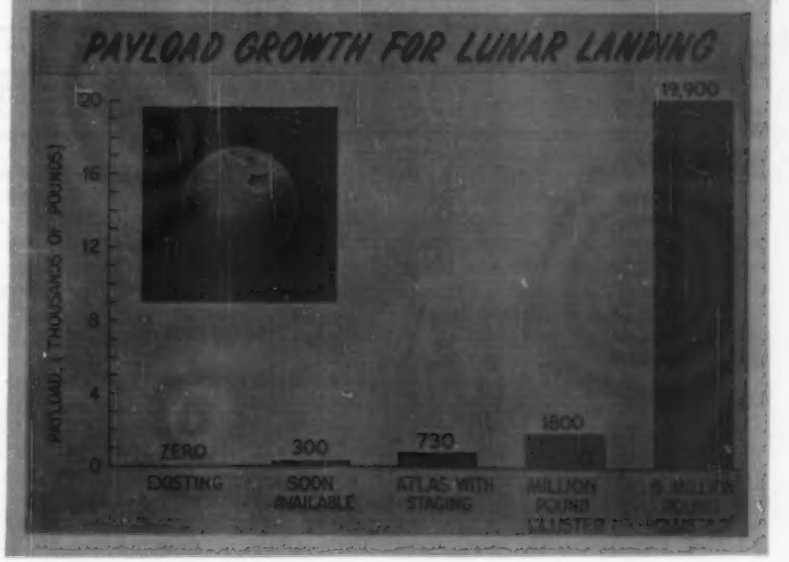
• **Cluster** of 1.5-million lb. thrust engines (presumably the single-chamber engine now under development for NASA by Rocketdyne) for a first stage; single 1.5-million lb. thrust engine for second stage; lox-hydrogen third and fourth stages; a storable fifth stage.

All the stages for these vehicles exist or are under contract. NASA and ARPA now have under development 15,000-lb. and 80,000-lb. lox-hydrogen engines; 6,000 and 20,000-lb. storable liquid engines; and the two 1.5-million lb. engines, using lox and kerosene.

The 1.5-million lb. thrust cluster is







U.S.—U.S.S.R: Satellites and Space Probes

Name	Origin	Designation	Launch Date	Lifetime or End	Dimensions (in.) length x diam.	Shape	Weight (lb.)	Initial Altitude (miles)		Speed (mph.)	
								Perigee	Apogee	(Perigee)	(Apogee)
Sputnik I	U.S.S.R.	1957 Alpha	Oct. 4, '57	Jan. 4, '58	22.8	Sphere	184	142	588	18,000	16,200
Sputnik II	U.S.S.R.	1957 Beta	Nov. 3, '57	Apr. 13, '58	.....	Complex	1,120	140	1,038	18,000	15,100
Explorer I	U.S.	1958 Alpha	Jan. 31, '58	3-5 years	80 x 6	Cylinder	30.8	224	1,573	18,400	13,700
Vanguard I	U.S.	1958 Beta	Mar. 17, '58	2000 years	6.4	Sphere	3.25	404	2,465	18,400	12,400
Explorer III	U.S.	1958 Gamma	Mar. 26, '58	June 27-29 '58	80 x 6	Cylinder	31.0	118	1,740	18,860	13,450
Sputnik III	U.S.S.R.	1958 Delta	May 15, '58	1-2 years	141 x 68 (at base)	Cone	2,925	130	1,167	18,337	14,637
Explorer IV	U.S.	1958 Epsilon	July 26, '58	2 years	80 x 6	Cylinder	38.43	162.9	1,373.3	.....	.....
Pioneer I	U.S.	.....	Oct. 11, '58	43 hr. 4 min.	30 x 29	Toroid	85	.....	71,300	.....	.....
Pioneer III	U.S.	.....	Dec. 6, '58	38 hr. 6 min.	23 x 10	Cone	12.95	.....	63,580	.....	.....
Project Score	U.S.	.....	Dec. 18, '58	Jan. 21, '59	1020 x 120	Cylinder	8,700	114.5	928	.....	.....
Mechta	U.S.S.R.	.....	Jan. 2, '59	.....	.....	Sphere	796.67	90,972,960†	122,840,080‡	.....	.....
Vanguard II	U.S.	1959 Alpha	Feb. 17, '59	100+ years	20	Sphere	21.5	329.4	2,086.5	18,379	13,041
High altitude earth satellite	U.S.	.....	.....	.....	.....	.....	325 (est.)	500 (est.)	30,000 est.)	.....	.....
Venus probe	U.S.	.....	.....	.....	.....	.....	78 (est.)	.....	26,000,000+	.....	.....
Venus satellite	U.S.	.....	.....	.....	.....	.....	325 (est.)	.....	.....	.....	.....
Discoverer	U.S.	.....	.....	.....	.....	.....	1,300-10,000	.....	.....	.....	.....
Mercury	U.S.	.....	.....	.....	.....	.....	2,400	110 (est.)	120 (est.)	.....	.....
Sentry	U.S.	WS-117L	.....	.....	.....	.....	400-500	190 (est.)	190 (est.)	.....	.....
Scout	U.S.	.....	.....	.....	.....	.....	150 (est.)	300 (est.)	300 (est.)	.....	.....
Midas	U.S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

NASA and ARPA will launch a number of navigation, communications and meterological satellites this year in addition to above programs.

Notes:
† Perhelion.
‡ Aphelion.
/ Inclination to major axis of earth's orbit.
* See AW, Jan. 19, '59 p. 30.

ARPA — Advanced Research Projects Agency.
NASA — National Aeronautics and Space Administration.
USAF — United States Air Force.
spr — Solid propellant rockets.

expected to be static tested this year and the program includes four booster test flights. ARPA already is considering ordering up to 16 engines and is studying feasibility of recovering boosters.

The 1.5-million lb. single chamber engine, which has progressed from USAF's initiation of preliminary studies in 1957 to ARPA-USAF supervision to NASA supervision, is believed to be at least four years away from use. Clusters would follow still later.

NASA also has taken over USAF's support of the Project Rover nuclear rocket reactor program.

NASA has given Congress these figures on payload capabilities of the various vehicles now in development, and a rough comparative timetable:

• **300-mi. orbits**—vehicles existing now, 100-150 lb. payload; vehicles soon available, 2,000 lb.; Atlas with staging, 7,400 lb.; 1.5-million thrust cluster plus staging, 19,000-25,000 lb.; 6-million lb. thrust cluster, 150,000 lb.

• **22,000-mi. orbits**—now, nothing; soon, nothing; Atlas with staging, 1,300 lb.; 1.5-million thrust cluster, 3,300 lb.; 6-million lb. thrust cluster, 150,000 lb.

• **Lunar landings**—now, nothing; soon, 300 lb. payload; Atlas with staging, 730 lb.; 1.5-million lb. thrust cluster, 1,800 lb.; 6-million lb. thrust cluster, 19,900 lb.—which would include a manned vehicle with enough thrust to take off and return to earth.

Mars missions can be accomplished either with chemical or nuclear rockets, NASA says, but the difference in utility is illustrated by the estimates for the payloads each could carry. First figure is the outbound load, second is the payload on the return to earth.

• **Chemical**—7,500 lb. outbound; 750 lb. return.

• **Nuclear**—55,000 lb. outbound; 25,000 lb. return. This would allow manned exploration.

U. S. satellite and space probe launchings in 1958, all but one of them done

Period (min.)	Inclination to Equator (degrees)	Launching Vehicle				Remarks
		Designation	Stages	Thrust (lb.)	Weight (lb.)	
96.17	64.3	T-3A	3	.....	190,000	Aluminum alloy satellite; recorded internal temperatures, pressures, and other data.
103.73	65.4	.....	.....	.....	.....	Aluminum alloy satellite; carried dog; measured temperatures, pressures, cosmic rays; solar, ultra-violet and X-radiation, and dog's reactions.
114.8	33.3	Jupiter-C	4	84,000	64,000	Steel satellite; measured cosmic rays; micrometeorites and internal and external temperatures.
134.29	34.25	Vanguard	3	36,000	22,600	Aluminum satellite; recorded temperatures.
115.9	33.37	Jupiter-C	4	84,000	64,000	Steel satellite; measured cosmic rays, micrometeorites, internal and skin temperatures. (Explorer II failed to go into orbit on Mar. 5.)
106	65	.....	.....	.....	.....	Aluminum alloy satellite; measured temperature, pressure, micrometeorites; atmospheric composition, positive ion concentration; satellite's electrical charge, and tension of earth's electrostatic field and magnetic field; analyzed cosmic radiation.
110.2	50.82	Jupiter-C	4	84,000	64,000	Steel satellite; measured corpuscular radiation.
.....	.....	Able-I	4	160,000	111,000	Lunar probe. Carried infrared television scanner and instruments to measure moon's magnetic field, radiation, micrometeorites and temperature.
.....	.....	Juno II	4	151,000	121,000	Space probe to measure radiation. (Pioneer II failed to go on Nov. 8.)
100	.....	Atlas 10-B	1½	290,000	244,000	Communications relay satellite; carried 168-lb. payload.
420 days	15	.....	.....	.....	.....	Aluminum-magnesium asteroid with instruments to measure detection of meteorites and interplanetary gases; cosmic radiation; solar radiation and temperatures.
125.9	33.2	Vanguard	3	36,000	22,600	Weather satellite with photocells to scan earth's cloud cover.
.....	.....	Able III	4	160,000+	.....	Forerunner for Venus shot; will measure radiation and earth's magnetic field.
.....	.....	Able IV Thor	3	160,000	.....	Will record data on Venus' surface and atmosphere; will carry pop-out solar panels.
.....	.....	Able IV Atlas	4	370,000+	.....	Instrumentation will be similar to that of Able III plus solar pop-out panels.
.....	.....	Thor booster Hustler 2d stage	2	.....	.....	ARPA project to gather general data to aid in satellite development. Thor booster initially; may use Atlas. Bell Hustler rocket engine will be 2nd stage.
.....	.....	Atlas D	.....	.....	.....	NASA man-in-space program.
.....	.....	Atlas	1	.....	.....	USAF reconnaissance satellite; formerly Pied Piper. Discoverer program to test Sentry technique and components.
.....	.....	.....	4	.....	35,000	NASA satellite or probe to sound space around earth. To use clustered spr; initial contracts let.
.....	.....	.....	.....	.....	.....	ARPA Missile Defense Alarm Satellite which will detect ballistic missile launching by infrared and other techniques.

in connection with the International Geophysical Year, were modest. Even so they provided such scientifically useful results as the discovery and valuable exploration of two intense high-energy radiation belts surrounding the earth and extending from about 250 mi. to 3,400 mi. and from 8,000 to 12,000 mi. altitude; communications experiments; new understanding of the earth's shape, and considerable experience in instrumentation, production, launching and tracking techniques.

Successful launchings (see table) were:

• **Three Explorer** satellites of about 30 lb. each, designed and launched by the Army Ballistic Missile Agency and Jet Propulsion Laboratory and using Jupiter-C vehicles. These established the existence of and explored the radiation belts using instrumentation developed by Dr. James Van Allen and associates at the State University of Iowa. Three other Explorers, including one carrying an ejectable, inflatable 12-ft. aluminum sphere, failed to go into orbit. The JPL team now has been transferred to NASA.

• **Pioneer I.** This vehicle was intended to put an 84-lb. payload out to the vicinity of the moon. Actual distance reached was 71,300 mi. from earth, but some radiation data, producing the first suspicion that a second band existed, resulted from its flight. USAF and Space Technology Laboratories, Inc., carried out the project, using a modified Thor-Able vehicle. Two other similar vehicles failed to send their payloads into useful trajectories. At least two of these vehicles are programed for use this year by NASA.

• **Pioneer III.** This ABMA vehicle, designated Juno II and using a Jupiter booster and the same JPL upper stages as the Explorer launchers, also was intended to send its payload to the moon's vicinity. It, too, fell short, reaching 63,580 mi. altitude. But it collected radiation data from both belts on its upward and downward passes. NASA expects to make use of at least eight Juno IIs in 1959 and 1960.

• **Score satellite.** This ARPA-USAF project put an Atlas into a short-life orbit carrying about 168 lb. of communications equipment with which a number of ground-to-satellite and satellite-to-ground transmissions were made.

• **Vanguard I.** This tiny 3.25-lb. test sphere, carrying only solar batteries, a radio and the ability to sense gross temperature changes, and launched last Mar. 17 by a Martin-Vanguard test vehicle, was the only success in Vanguard's year of failure. But its diminutive radio is still working and tracking of it has provided new information on the earth's shape. Orbital information also has been used to locate small land masses precisely and recalibrate Minitrack stations. Navy's Vanguard team at the Naval Research Laboratory was transferred to NASA. After a long layoff, the Vanguard vehicle put a full-sized, 21-in. sphere containing infrared cloud cover scanners into orbit in mid-February of this year.

Push from Sputnik

All these satellite projects, with the exception of Vanguard, were ordered after the first Russian Sputnik was put into orbit on Oct. 4, 1957. While all were expensive and inefficient from the standpoint of booster-to-pay load ratio, they clearly demonstrated the value of space exploration.

Aside from the ARPA-USAF Sentry reconnaissance satellite program, the NASA-USAF Dyna-Soar orbital bomber, and the NASA-USAF-Navy X-15 rocket research aircraft, which will explore manned flight on the outer fringes of the atmosphere and produce heating, stability, control, pilot reaction and reentry information, the major NASA and ARPA space programs for the near future include:

• **Project Mercury.** This will be the first U. S. attempt to put a man into an orbit around the earth and recover him. Selection of pilots is well along. McDonnell Aircraft Corp. has been

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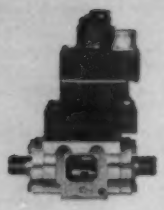
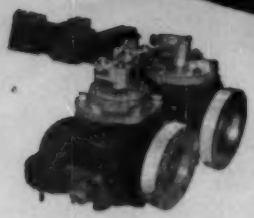
TYPICAL APPLICATIONS: Ground support LOX topping on ICBM and LOX fueling trailers for IRBM.



MODEL 125F
1-INCH line, 3,000 **PSI** rated pressure. **DC MOTOR** operated, with automatic current shut-off and positive Geneva-Lock mechanism. Weight 3.5 **LBS.**
TYPICAL APPLICATION: Airborne ICBM propellant pressurization control valve.



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TYPICAL APPLICATION: Airborne rocket engine main propellant valve for manned space vehicle.

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1/2-INCH line, 1,000 **PSI** rated pressure. Pressure operated, full travel **RESPONSE 25 MILLISECONDS.** Weight 1.9 **LBS.** Includes externally adjustable valve position switch.
TYPICAL APPLICATION: Airborne LOX bleed control on ICBM.

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awarded a $15 million contract to provide a dozen or so capsules. Extensive tests will precede the first orbital flight, which will be boosted by an Atlas D missile booster. NASA by the end of January already had awarded Air Research and Development Command's Ballistic Missile Division $7 million for Atlas D boosters and final amount of the contract still is under negotiation. A number of firings of solid rocket test vehicles equipped with capsules will precede the first orbital flight, with launchings from NASA's Pilotless Aircraft Research Station at Wallops Island, Va. Also scheduled ahead of the first orbit are test firings of capsules containing animals and men over shorter ballistic trajectories from Cape Canaveral, Fla., using ABMA-Chrysler Redstone and Jupiter boosters. Even these shorter flights will have to be preceded by static tests with the man inside the capsule to study physiological and psychological effects of noise, vibration, etc., and possibly also the safety escape mechanisms. Contracts awarded by the end of January totaled more than $17 million, excluding the capsule.

• **Earth satellites** to be launched by Air Force for NASA. So far this program calls for spending $7.12 million, most of it for Thor-Able boosters. One shot, designated Thor-Able III, is expected to be launched next month to send a satellite into an orbit with a 30,000 mi. apogee.

• **Earth satellites** to be launched by ABMA for NASA. These will use Juno II boosters. Total of $8.54 million has been contracted for the vehicles.

• **Army lunar probes** for NASA. A little over $2 million already has been contracted for. This may cover only the shot fired last December and one scheduled for late February or early March.

• **USAF lunar probes** for NASA. The $2 million contracted for may have covered only shots already fired.

• **USAF deep space probes** for NASA. Ballistic Missile Division has received $8.99 million for this, indicating it calls for more than the Thor-Able and Atlas-Able shots at Venus, which will be fired about June 3 and June 4 if development proceeds fast enough.

• **Launching** of 40 sounding rockets. These may include vehicles as large as the Jupiter.

NASA early this year had 12 complete satellite systems on order, using Jupiters, Thor-Ables and Atlases as launchers. Some were scheduled for 1959 firings.

Satellites in this group or later groups plus space probes and sounding rockets will be used to study:

• **Structure and composition** of the atmosphere, with emphasis on daily, geographic and seasonal variations and relationships between surface meteorology and the structure and dynamics of the upper atmosphere.

• **Electron density** profiles of the ionosphere at altitudes above the F-2 region (about 180 mi.). Latitude and time variations of electron density and other phenomena will be obtained by using a polar-orbiting satellite beacon.

• **Types, distribution** and interaction with earth's atmosphere of high energy particles.

• **Electric and magnetic fields,** including satellite investigations of the ring currents above the ionosphere and their relations to magnetic storms.

• **Study of gravitational fields,** using a carefully instrumented satellite launched into a very high orbit to obtain precise geodetic data over a long period of time. A highly accurate clock will be launched in another satellite to test the general theory of relativity.

• **Study of astronomy,** including scanning satellites and rockets to observe the previously unexplored infrared and high-energy gamma ray spectral regions, and rocket study survey of the nebulosities in the far ultraviolet region, a phenomenon discovered during the IGY. These studies will be followed by a satellite observatory program. NASA plans to use a scanning satellite at an early date to map the emission of the high atmosphere which derives from charged particle interactions and photochemical reactions.

ARPA's major space programs include:

• **Discoverer.** A series of launchings, chiefly from the Pacific Missile Range, to develop new systems and techniques for producing and operating military space vehicles. Later launchings will carry biomedical experiments leading toward Project Mercury. This program consists largely of work split off from the original USAF-Lockheed WS-117L Pied Piper reconnaissance program.

• **Navigation satellites.** Several satellite tests are planned for the first six months of 959. Program moved into the active stage last September. First satellite will be a 150-lb. battery-powered package, expected to stay aloft about three months. Purpose is to institute a precise all-weather system for determining positions at sea or in the air at any point on the globe.

• **Communications satellites.** Several experimental versions are to be launched this spring and summer. In 1960 or 1961, "fixed" satellites are to be established 22,000 mi. out to relay radio, television and teletype messages.

• **Meteorological satellite.** First launching is planned for fall or early winter, after the project transfers to NASA on July 1. Four satellites are scheduled for delivery in 1959.

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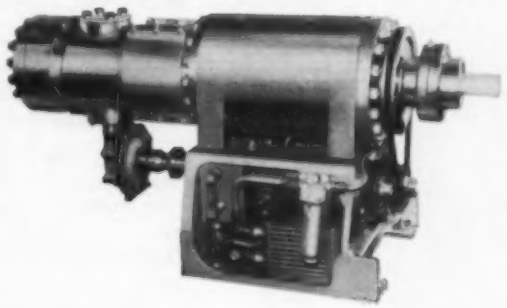

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U.S. Research and Test Vehicles

	GENERAL				AIRFRAME				
CATEGORY	Vehicle name	Military designation	Cognizant service	Prime contractor	Manufacturer	Over-all length, less booster, ft.	Over-all span, wings or fins, ft.	Body diameter, ft.	Launching wt., less booster, lb.
Satellite vehicles	Atlas Able	.....	USAF/NASA	.....	.....	....	...	10	.....
	Jupiter-C	.....	Army/NASA	ABMA/JPL	ABMA	60	...	5.8	84,000
	Juno II	.....	Army/NASA	ABMA/JPL	ABMA	76.5	...	8.8	121,000
	Nova	.....	NASA	.....	.....	....	...	...	.....
	Saturn	.....	Army	ABMA	ABMA	....	...	...	.....
	.....	WS-117L	USAF	Lockheed Aircraft	Convair	....	...	8	.....
	Thor-Hustler	.....	ARPA	Lockheed Aircraft	.....	....	...	8	.....
	Thor-Able	.....	USAF/NASA	Space Technology Labs.	.....	88.1	...	8	.....
	Vanguard	.....	NRL/NASA	Martin	Martin	72	...	3.8	22,600
Test Vehicles	Cherokee	.....	USAF	Cook Electric	.....	25	...	4.2	4,500
	Cree	.....	USAF	Cook Electric.....	.....	....	...	...	.....
	Pogo-Hi	.....	.....	U. of New Mexico	.....	....	...	...	.....
	Skokie I	.....	USAF	Cook Electric	.....	25	...	1.7	2,400
	.....	X-7	USAF	Lockheed Aircraft	Lockheed Aircraft	....	...	...	.....
	.....	X-17	USAF	Lockheed Aircraft	Lockheed Aircraft	40	...	...	.....
Research Vehicles	Aerobee	AJ10-25	Army-Navy-USAF	Aerojet-General	Aerojet-General	19	...	1.3	.....
	Aerobee 75	.....	Army	Aerojet-General	Aerojet-General	19	...	1.2	.....
	Aerobee 150	AJ11-6	Navy-USAF	Aerojet-General	Aerojet-General	21	...	1.3	.....
	Aerobee 300	.....	USAF	Aerojet-General	Aerojet-General	....	...	1.3	.....
	Areas	.....	Navy	Atlantic Research	Atlantic Research	6.5	1.2	0.4	71
	Arcon	.....	Navy	Atlantic Research	Atlantic Research	11.1	2.1	0.5	250
	Asp	.....	Navy	Cooper Development	Cooper Development	12	1.7	0.5	245
	Aspan	.....	Navy	Cooper Development	Cooper Development	14.1	1.8	0.5	1,500
	Cajun	.....	USAF	U. of Michigan	.....	13.3	2	0.5	254
	Dan	.....	Navy	Cooper Development	Cooper Development	27	2.1	0.5	1,482
	Deacon	.....	NASA	ABL	.....	9.2	...	0.5	153
	Hasp	.....	Navy	Cooper Development	Cooper Development	6	...	0.3	.....
	HTV	.....	USAF	ADC	.....	13	...	0.8	220
	Iris	.....	Navy	Atlantic Research	Atlantic Research	16.3	3.7	1	1,229
	Jason	.....	NASA	.....	.....	55	...	...	7,000
	Nike-Nike	.....	USAF	Marquardt	Cooper Development	22.2	1.4	1.3	2,540
	Nike-Cajun	.....	USAF	Cooper Development	.....	26.7	1.8	0.5	1,495
	.....	.....	AEC	Cooper Development	Cooper Development	20.4	1.7	0.5	408
	Rockair	.....	Navy	.....	.....	4	...	0.2	18
	Rockaire	.....	USAF	Douglas	.....	8.9	1.7	0.8	181
	Wasp	.....	Navy	Cooper Development	Cooper Development	....	...	...	.....

Abbreviations:
ABL — Allegany Ballistic Laboratory
ABMA — Army Ballistic Missile Agency
ADC — Aerophysics Development Corp.
ARPA — Advanced Research Projects Agency
JPL — Jet Propulsion Laboratory
N.A.A. — North American Aviation (Rocketdyne Div.)
NASA — National Aeronautics and Space Administration
NRL — Naval Research Laboratory

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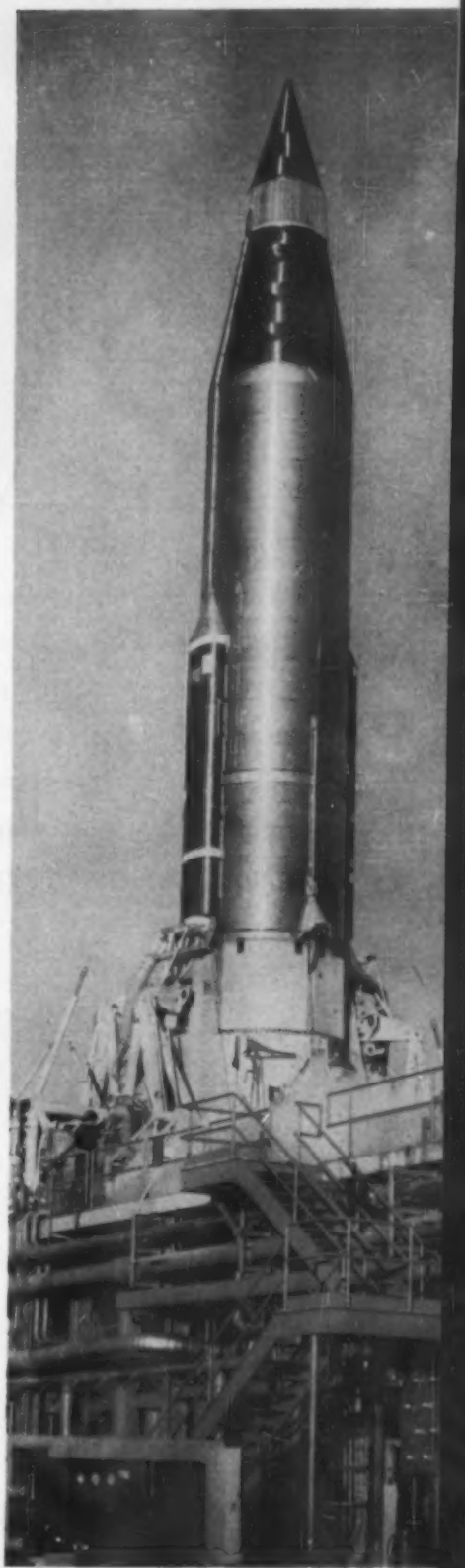
POWERPLANT				
Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	REMARKS
N.A.A. Aerojet-General Allegany Ballistic Lab.	3 1 1 1	lpr AJ-10 lpr ABL-248 spr spr	360,000 7,500 2,500	Also known Able IV Atlas; 4th stage retrorocket; carrier for Venus satellite; with other upper stages will form other carrier vehicles such as Atlas Hustler, Centaur, and Vega for various space-satellite missions.
N.A.A. JPL	1 15	lpr spr	83,000 1,000	Four-stage carrier for Explorer satellites; first stage a modified Redstone; later stages scaled down Sergeant rockets.
N.A.A. JPL	1 15	lpr spr	150,000 1,000	Four-stage carrier for Pioneer III lunar probe; first stage a modified Jupiter; upper stages scaled down Sergeant rockets.
N.A.A. N.A.A.	4 1	lpr lpr	6,000,000 1,500,000	Up to five stages depending upon mission; stages 3 and 4 liquid hydrogen and oxygen; 5th storable lpr engine
N.A.A.	....	lpr	1,500,000	Super booster now in research and development phase.
N.A.A.	3	lpr	360,000	Reconnaissance satellite; will use Atlas.
N.A.A. Bell Aircraft	1 1	lpr lpr	150,000	Two-stage carrier for Discoverer satellite; will use Thor first stage, engine developed by Bell for B-58 pod as second stage.
N.A.A. Aerojet-General Allegany Ballistic Lab. Thiokol Chemical	1 1 1 1	lpr AJ-10 lpr spr ABL-248 spr	150,000 7,500 2,500	Also known as Able I; carrier for Pioneer II lunar probe; 2nd stage is Vanguard 2nd stage; 4th stage is Falcon motor used as a retrorocket; with minor modifications will become Able III and Able IV Thor carriers.
General Electric Aerojet-General Grand Central	1 1 1	lpr lpr, AJ-10 spr	27,000 7,500 1,440	Three-stage carrier for Vanguard satellites.
.....	1	spr	50,000	Test vehicle for ejection seat development; air launched.
.....	....	.....	.....	Supersonic vehicle will be used by WADC to test 14-18 in. parachutes for missiles, drones and escape capsules.
.....	....	.....	.....	Infra-red, high altitude target for heat-homing missiles.
.....	3	spr	33,000	Air-launched parachute test vehicle; Skokie II is Mach 2 version.
.....	1	rj	.....	Ramjet engine test pod.
Thiokol Chemical	5	spr	.....	Three-stage re-entry test vehicle.
Aerojet-General	1	lpr	4,000	Sounding rocket; 150-lb payload to 70 mi.
Aerojet-General	1	dual thrust spr	.....	Sounding rocket; 90-lb payload to 75 mi.; also called Aerobee Hawk.
Aerojet-General	1	lpr	4,100	Formerly Aerobee-Hi, sounding rocket; 150-lb. payload to 150 mi.; has 18,000-lb. thrust booster.
Aerojet-General	1 1	lpr spr	4,100	Also called Spaerobee; Sparrow I second stage; Aerobee-Hi first stage; sounding rocket; 50-lb. payload to 300 mi.
Atlantic Research	1	spr	.....	Sounding rocket; 40-lb. payload to 70 mi.
Atlantic Research	1	spr	.....	Sounding rocket; 100-lb. payload to 300 mi.
Cooper Development	1	spr	5,850	Sounding rocket; 25-lb. payload to 38 mi.
Cooper Development	1 1	Nike JATO M-5 Asp I spr	.....	Two-stage sounding rocket; 50-lb. payload to 160 mi.
Thiokol Chemical	1	spr	8,300	Sounding rocket.
.....	1 1	Nike JATO M-5 Deacon spr	.....	Two-stage sounding rocket; 50-lb. payload to 75 mi.
ABL	1	spr	.....	Sounding rocket.
Cooper Development	....	.....	3,300	Weather rocket; 35-mi. altitude capability.
.....	11	spr	.....	Two-stage hypersonic test vehicle.
Atlantic Research	1	spr	.....	Sounding rocket; 12-lb. payload to 40 mi.
.....	5	spr	.....	Five-stage research vehicle; consists of Honest John, 2 Nike boosters, Recruit and T-55 engines.
..... Thiokol Chemical	1 1	Nike JATO M-5 spr	.....	Two-stage sounding rocket; 50-lb. payload to 105 mi. Another version of Nike-Cajun used in Navy's Project Hugo weather program.
.....	2	Nike JATO M-5	.....	Test vehicle.
JPL Cooper Development	1 1	6"-427 Asp I spr	.....	Two-stage sounding rocket; recoverable payload.
.....	1	spr	.....	2.75-in. FFAR rocket instrumented for sounding experiments.
.....	1	DM-16 JATO	7,800	Air-launched sounding rocket; 40-lb. payload.
Cooper Development	....	.....	.....	Weather sounding vehicle.



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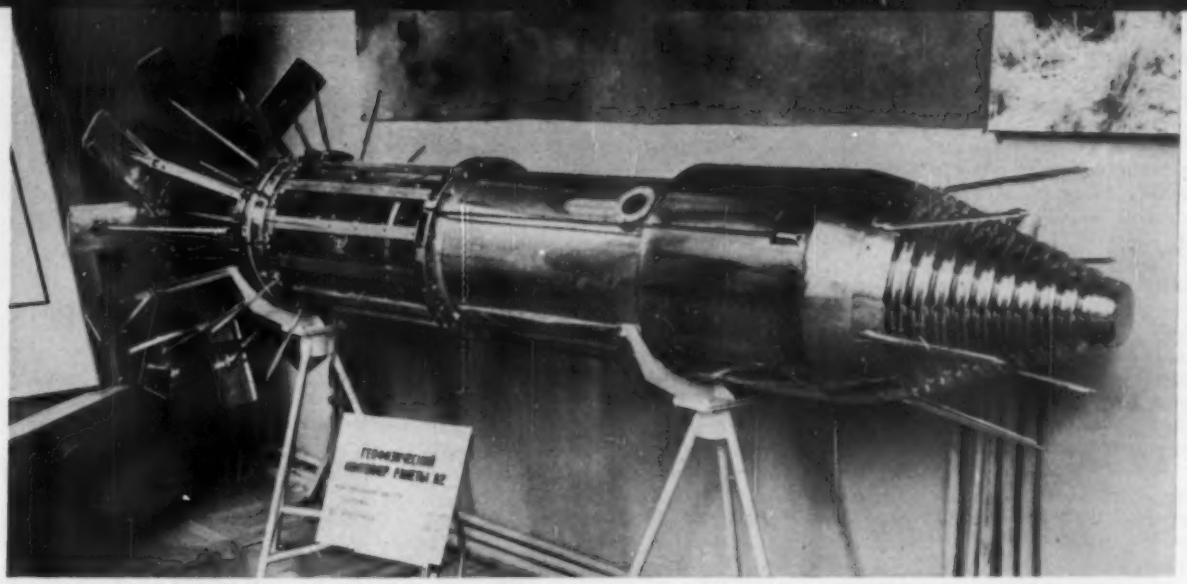


SOVIETS display mockup of 792 lb. instrument container of A2 research rocket, which has reached 131 mi. altitude.

Soviets Capitalize on Space Leadership

Washington—Soviet Russia is expected to retain her commanding lead in space technology for many years—probably for longer even than the four to five years estimated by U.S. experts in recent hearings before Congress.

A major reason for this is Soviet Russia's greater need for and appreciation of space flight achievements as weapons of propaganda and prestige, an appreciation still not fully shared by the U.S.

It is in the space field that Russia first surpassed all Western nations, clearly and spectacularly, in the eyes of the rest of the world, and she is not likely to relinquish her lead so long as Soviet science and the Soviet economy can keep her ahead.

The newest Seven-Year Plan for the advancement of the Soviet economy lays great stress on the importance of science as a tool for improving the lot of the average Russian, strengthening communism within the Soviet Union and achieving technological superiority over other nations.

The Soviet newspaper Pravda, reporting on the scientific aspects of the Seven-Year Plan, said it calls upon "all persons who are active in Soviet science and technology to perform new acts of heroism."

Soviet science approached the recent 21st Congress of the Communist party "with great victories which had resounded throughout the entire world," according to Pravda. And the "majestic program of expanded building of communism in our country . . . inspires the Soviet scientists to conquests of new summits and of preeminence in world science."

The scientific part of the plan calls for "special attention . . . to the strengthening and the establishment of institutes which work in the fields of new technical equipment, radio and electronics, automation and astronautics."

This includes accelerated organization of "scientists' cities, in Novosibirsk (basically with physical-engineering specialization); in Irkutsk (with chemical-engineering and geological specialization); in Puschino (a complex of physical-chemical biology), as well as (providing) for a rapid development of scientific institutions in the Academies of Sciences of the Union republics," Pravda said.

Sciences Stressed

The long-range plan for science places particular emphasis on these areas applicable to space technology:

- **"Solution** of the problem of controlling thermonuclear reactions" and better understanding of all phases of atomic physics. Preceding this effort must be more effective and economic utilization of solid, liquid and gaseous fuel, hydropower and atomic energy.
- **"Development** of new means of astronomical research both with the help of new powerful optical and radiotechnical instruments and with the help of space rockets and artificial satellites which permit carrying the instruments beyond the earth's atmosphere."
- **Solid-state physics,** on which depends the development of "aviation, shipbuilding, machine building, metallurgy, power engineering, radio technology and others. . . . There is no necessity to dwell on the importance and the present role of super-hard and heat resistant alloys, that is, materials which are suitable for atomic industry and rocket and aviation engineering."
- **Computer techniques,** design and production, including those to be used for control of production processes, statistical and accounting operations, planning and designing estimates, and language translation.
- **Automation** of production processes. In this field "it becomes of utmost importance to learn the natural sequences of production process and its mathematical expression," and automation will require "considerable revision and improvement of technology, and in many instances, designing and building new equipment, new systems and new technical means."
- **"Creation** of artificial materials possessing desired properties."
- **"Widening of research** in the realm of rare elements" for application to atomic power engineering, metallurgy, aircraft, machine building, chemical, radio and electronic and optical industries.

While these goals could be interpreted to indicate areas of weakness rather than strength, they demonstrate the degree and determination with which Russia is using science to advance the nation in all fields.

Although Russia's lead in the space field generally is credited primarily to its earlier start, at least one Congressional witness has laid most of the credit to better organization, and still others to Russia's recognition of the urgency and importance of space ex-

ploration for peaceful, military and propaganda purposes.

The future position of the U.S. vis-a-vis the Soviet Union in space achievements probably rests largely on such a sense of urgency. George S. Trimble, Jr., chief of The Martin Co.'s space division, has told Congress: "The hero of this age will not be the space traveler, but rather the man or men who successfully figure out how to motivate 170 million American people actively to do battle with a part of their environment that they just began to hear about, that they really did not know was important --Space."

Russia, not being a democracy, does not have a parallel problem. The Soviet government began demonstrating its understanding of the importance of space flight in 1954 and 1955 by integrating many phases of its military and space programs, supporting the space aspects fully, and using space exploration as a major instrument of national policy.

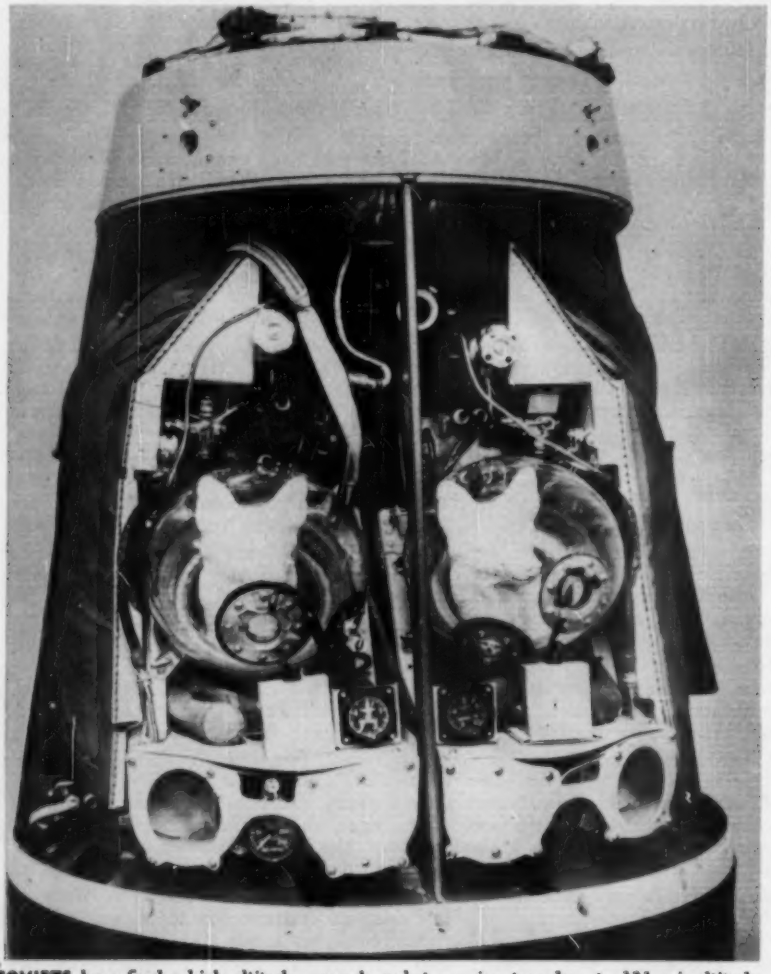
Announced Soviet achievements (see table p. 102) since Oct. 4, 1957—three heavily-instrumented satellites, including one that carried a dog for physiological experiments, and an instrumented rocket pass at the moon—plus discussion by her scientists of future plans, indicate that the Soviet program for space exploration is little different than that of the U. S., except in time scale.

In addition to the announced achievements, Russia is believed to have fired at least 12 other space probes of considerable size. These may have been attempts to reach the moon that failed, or planned, step-by-step excursions farther and farther into cislunar space.

Emphasis put on development of missile boosters since World War II and apparent progress in development of nuclear reactors for rocket use promise to help her maintain her lead for some time.

Achievements that either have been discussed openly by Soviet scientists or can reasonably be expected to occur in the near future include:

• **Orbiting of a manned satellite.** Some



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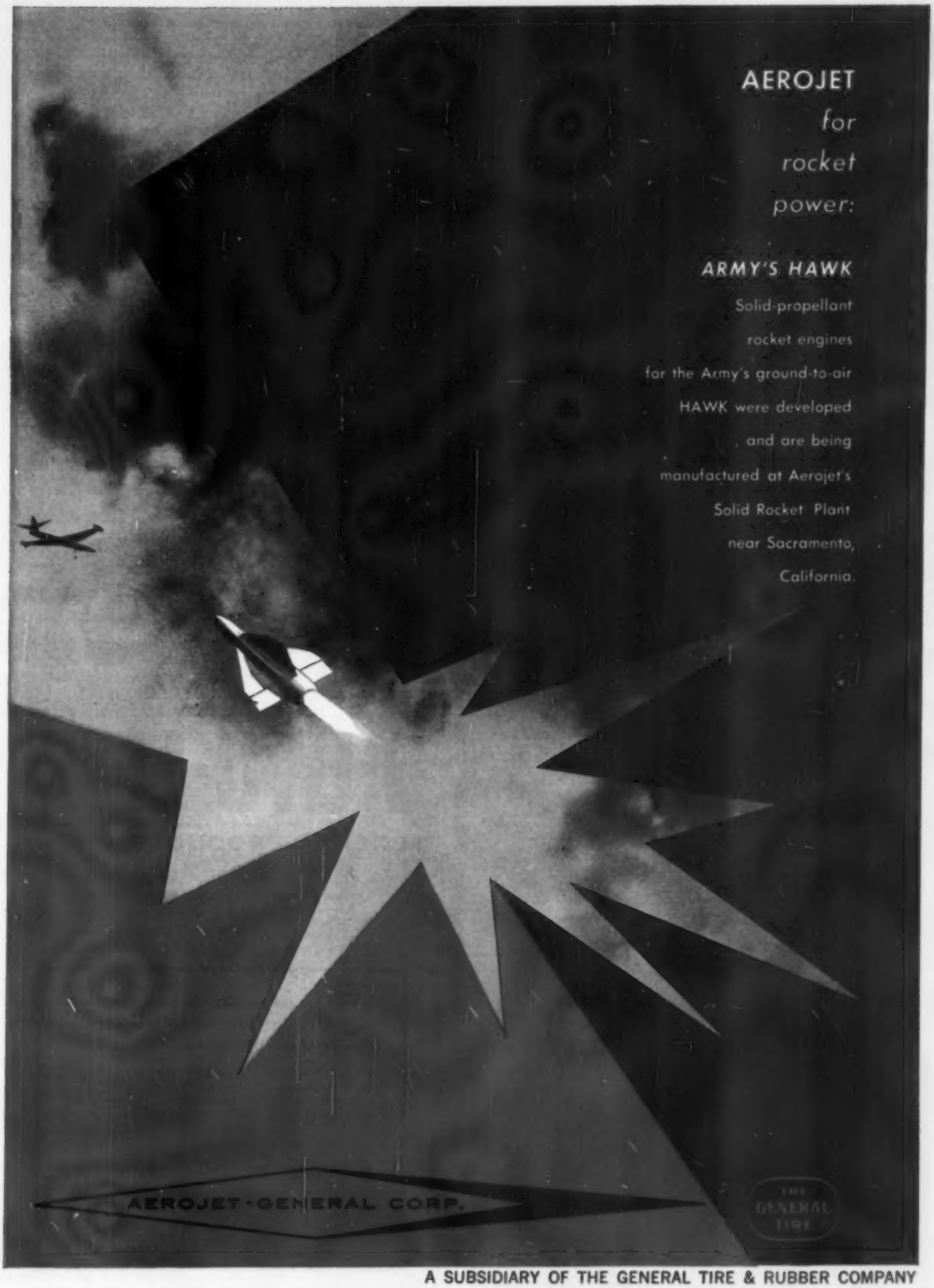

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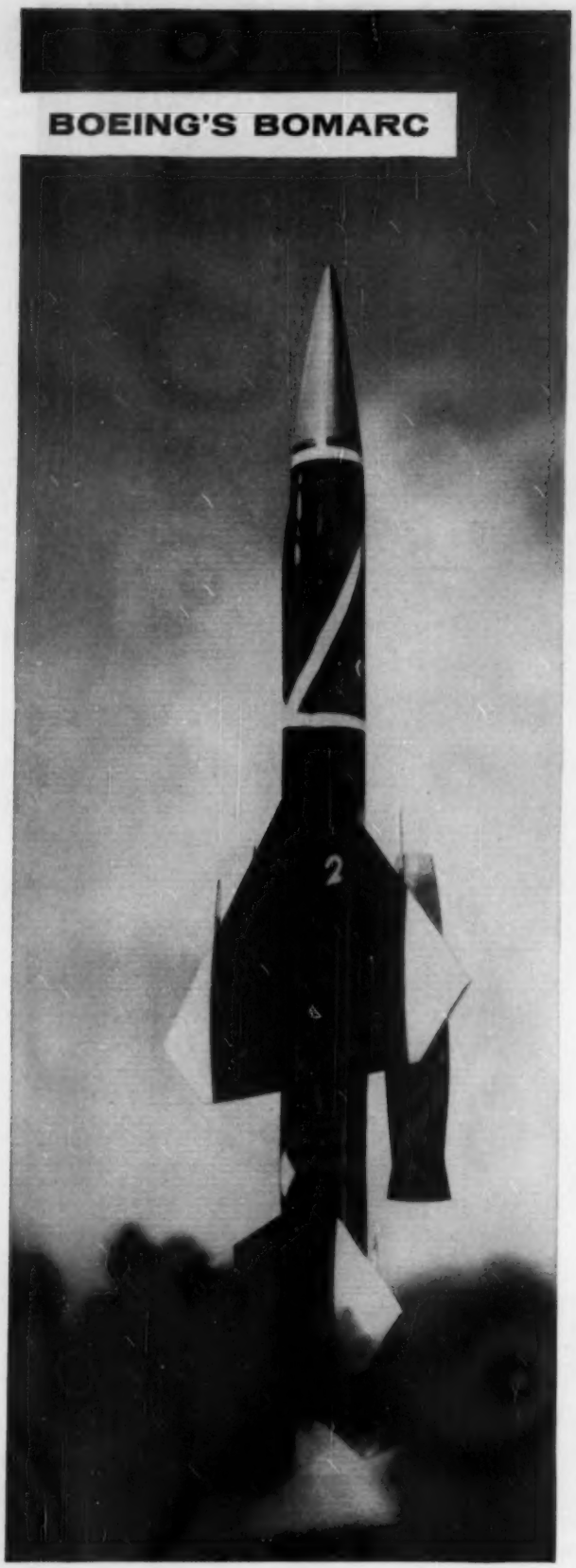

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U. S. experts expect this to occur this year. Although Soviet scientists have said from time to time that more orbital flights of animals must precede manned orbiting, their rockets already have demonstrated the payload capability to put man into orbit. Some U. S. observers believe the Soviets already have fired manned rockets along less-than-orbital trajectories.

On the anniversary of Sputnik I, Prof. V. Dobronravov claimed in Sovetskaya Aviatsiya that Russian scientists had almost solved the problem of returning an artificial satellite to earth. He said that the widely publicized flight of two dogs to an altitude of 279 mi. in a single-stage rocket with a 3,726.45-lb. payload last August was a preliminary test of a solution to satellite stabilization problems. Dobronravov said the rocket was devoid of transversal or longitudinal rotation.

Next Goals

He gave the two most immediate goals of the satellite program as launching of guided and returnable satellites, including manned vehicles, and launching of Sputniks near the moon.

- **Launching** of instrumented rockets to Venus and Mars. Most favorable time for a Venus shot occurs this June and the Soviets almost certainly will attempt to take advantage of it. U. S. plans call for two Venus shots, using Thor and Atlas boosters.
- **Launching of "eternal"** Sputniks into orbits that will give them almost unlimited life, and launching of Sputniks with very high apogees.
- **Landing of Sputniks** on the moon and launching of others that will circumnavigate the moon and return to earth. Prof. Vitaliy Bonshtayn, scientific adviser to the Moscow Planetarium, said a month or so before the Soviet moon rocket Mechta was launched that its firing was imminent, and said returnable satellites and manned vehicles would follow "in the near future."

In addition to these, President A. N. Nesmeyanov of the USSR Academy of Sciences said on the anniversary of Sputnik I that lunar and planetary shots would be followed by creation of an interplanetary satellite station on which a considerable number of men could remain for some time.

One unknown factor in the Communist space effort is the role to be played by Communist China, where a number of tracking stations, astronomical observatories and scientific institutes have been established along the Russian design.

The president of China's academy of sciences was quoted almost a year ago as saying that "Chinese scientists are determined to get China's artificial satellite into the sky at an early date. In order for this to materialize, we have to expend very great efforts. However, there will be a day when the artificial earth satellite of China will go into the sky. The earlier that day comes, the better."

The importance of China as a base for tracking and observing and its more favorable geographic location for launchings to the moon and planets would indicate that Russia might well assist the Chinese in building a rocket technology.

One major achievement that the Soviet Union can be counted on to attempt within a few years is a network of three or four communication satellites established in orbits 22,000 mi. out from earth, at which point each would appear to remain stationary relative to a point on earth.

The Soviets have for several years discussed the use of such satellites to provide radio or television coverage of the entire earth. Present U. S. plans call for the establishment of such a network in 1960 or 1961—and if this timetable can be met by the U. S., there is no reason why Russia could not do the same thing earlier.

First U. S. stations may simply be "passive"—serving only to reflect signals—but either these or later versions would carry receiving, amplifying and retransmitting equipment.

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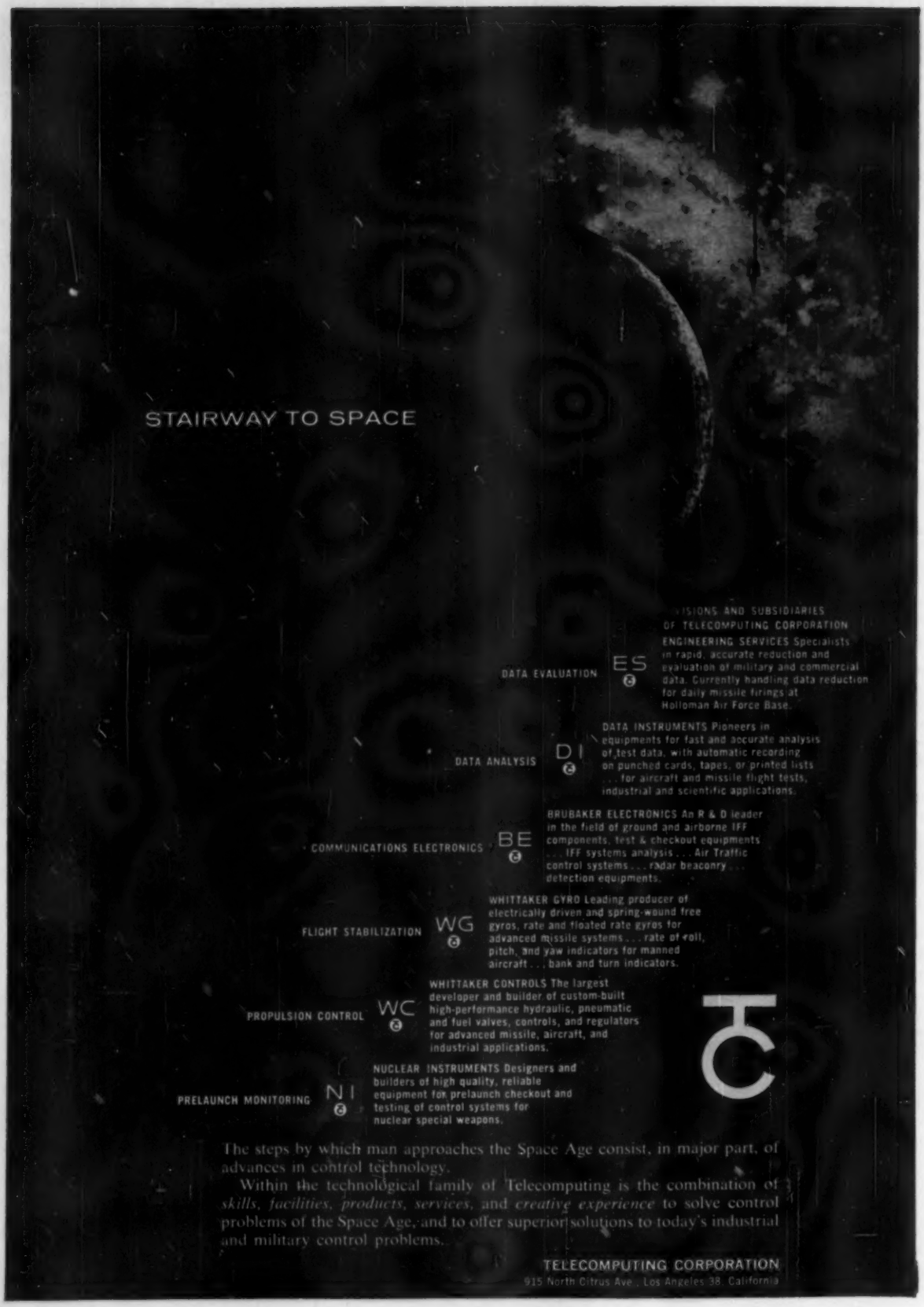
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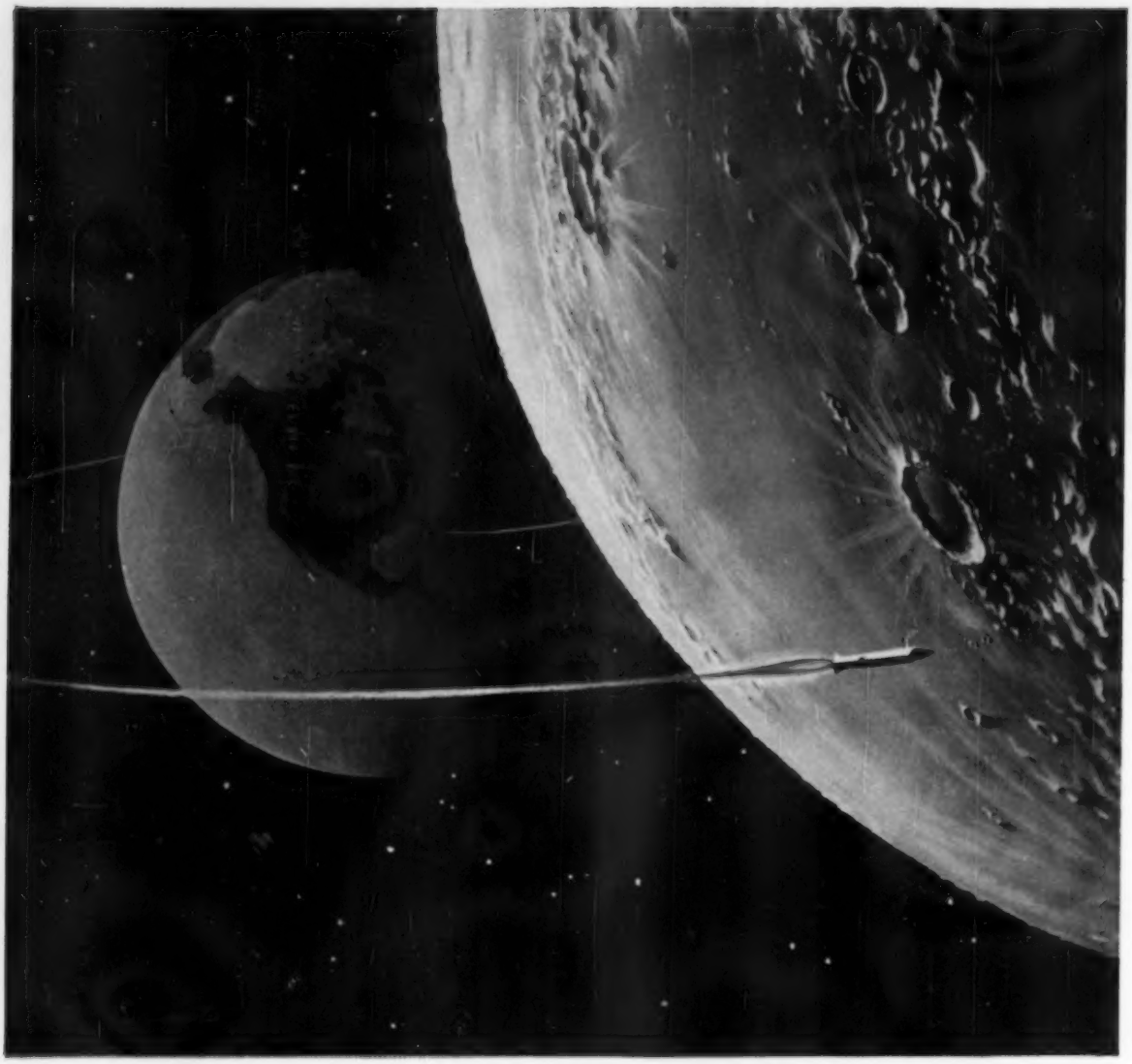

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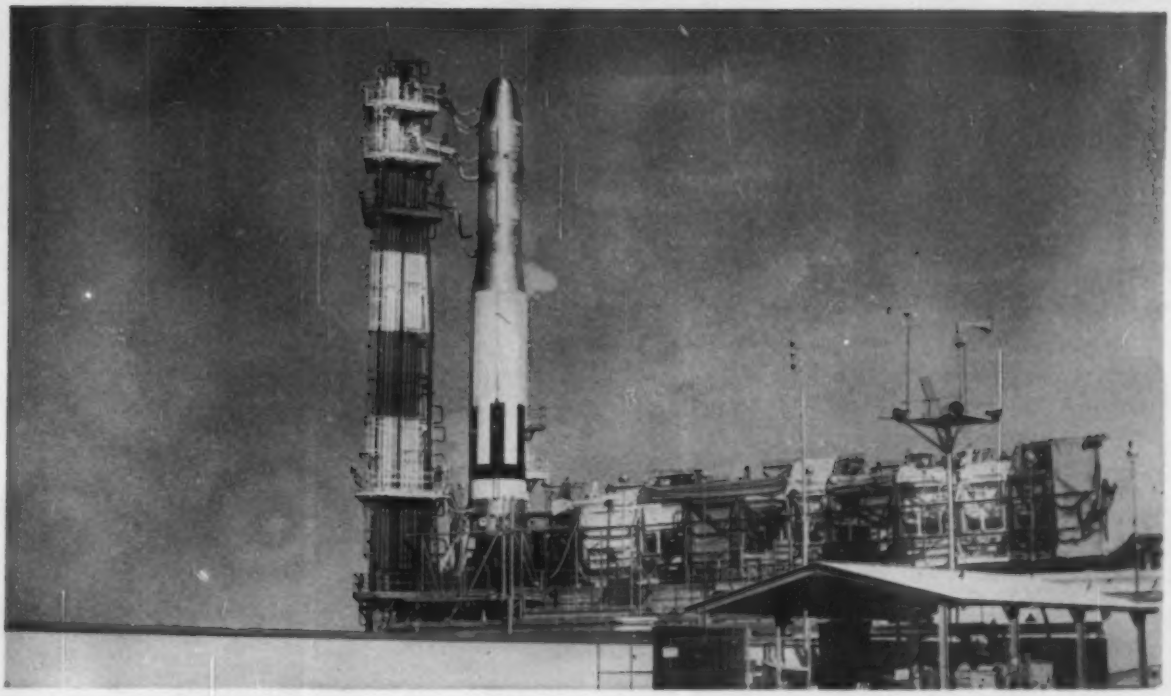


MARTIN TITAN ICBM

Missile Gap Flares as Crucial Issue

By Richard Sweeney

Los Angeles—The "missile age," that hypothetical point in time when U. S. retaliatory and defensive capability would depend to a significant extent on unmanned, rocket propelled weapons with electronic brains, came closer in 1958. But it did not arrive.

According to which political side one listened to, U. S. missile strength vis-a-vis Russian achievements was either basis for serene confidence or deep concern. Most especially the arguments raged over Soviet current and near-future capability in intercontinental ballistic missiles.

However, through the smoke of Washington battles and Cape Canaveral launchings, certain solid, substantial U. S. achievements could be clearly discerned. Items:

• **Thor** intermediate range ballistic missile was on threshold of true operational capability. It had been fired by using Strategic Air Command personnel using operational ground support equipment. It was being deployed to England where Royal Air Force No. 77 Squadron, first operational Thor-equipped unit, was working toward combat ready status.

• **Atlas ICBM** was fired full range, although its flight weight was not revealed nor did any hardware, such as a nose cone, impact into the ocean following the flight. Additionally, bases for Atlas operational units were coming along. Production rate on the missile itself was low, and did not appear headed for any increase. Hardware on the production line has now reached the 7,500 mi. operational D model configuration (AW Feb. 23, p. 23), but differences between the line items and combat versions were small—most essential parts of the weapon had been cranked into various ones of the total of 20 Atlases fired.

Missiles' Place

That the U. S. was not completely dazzled by rocket exhausts and shiny electronic circuitry was established when the Defense Department re-emphasized its belief that manned aircraft, ballistic missiles and airplanes carrying ballistic missiles to air launch points, together with manned interceptors using better guided missile weapons, were all parts of a properly balanced retaliatory and defense capability.

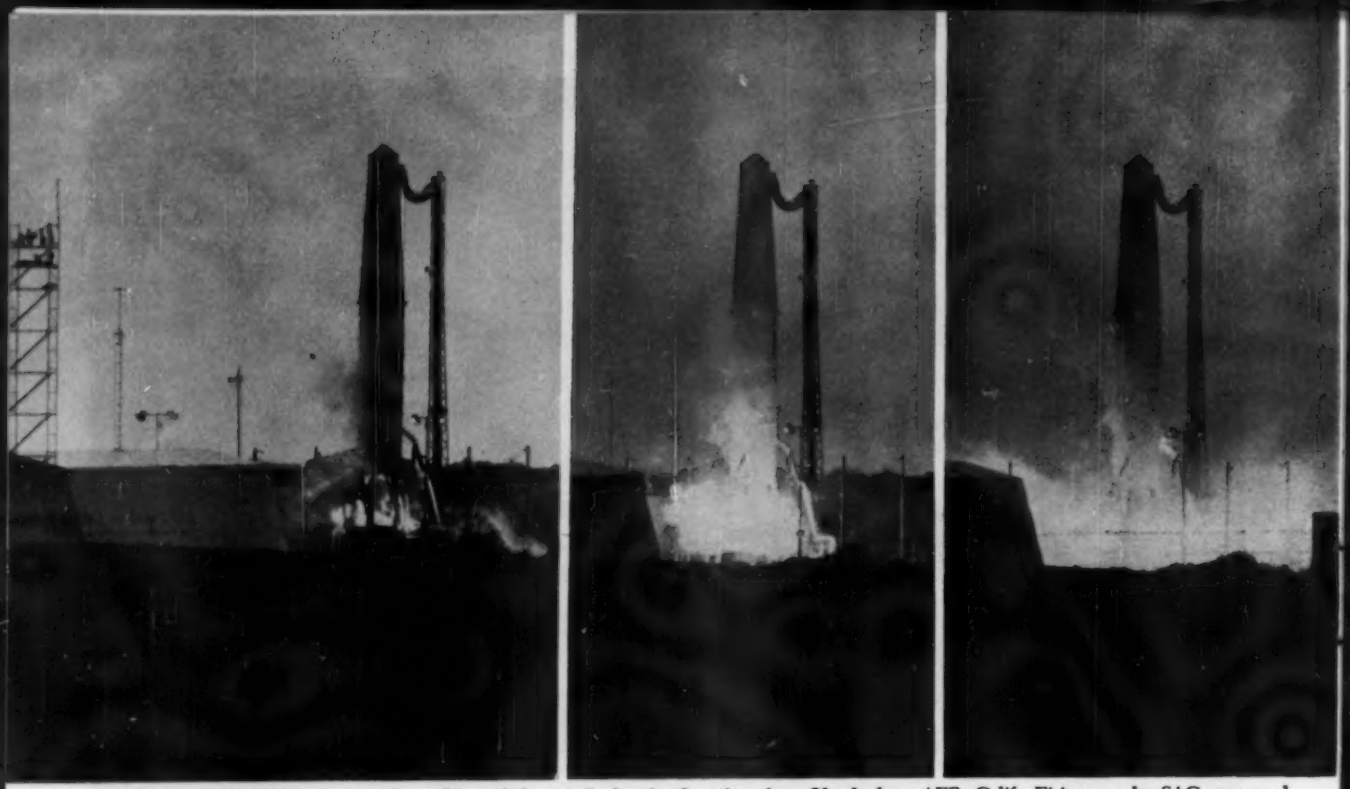
Work was under way on Dyna-Soar, the orbiting hypersonic gliding bomber/reconnaissance vehicle which weds man to missile in a weapon system. Dyna-Soar vehicle would be rocketed into orbit, staying there until recalled to base or sent back into the atmosphere for a hypersonic gliding attack against some enemy target before return. In Dyna-Soar, a human pilot is predominant; while automaticity may help him pilot and navigate his vehicle, he still has the power to act according to his unique ability to anticipate and discriminate.

Spending Shift

Missile spending appeared to have changed its course. New patterns appeared in funding descriptions which required expert analysis to get a true perspective of how many dollars were going to exactly what projects.

Apparent levels of financial support for various missile projects were indicated in budgets for Fiscal Years 1959 and 1960, but actual expenditures showed a different picture. Additionally, use of terminology such as "research, development, evaluation and test," without associating it to specific projects, left more murk in the waters.

One financial area which sparked caustic remarks in congressional debate was the appropriation of $1.3 billion for spending in Fiscal 1959, earmarked by Congress for specific missile projects, the majority of which was



DOUGLAS THOR IRBM sequence shows firing of the missile for the first time from Vandenberg AFB, Calif. Firing was by SAC personnel

not spent by the Administration.

In this case, Congress specified $609 million for the Polaris project, of which about $308.7 million was used for submarines to carry the missile and one tender, including $71 million for research. Remainder of money was not touched. Out of $48 million allotted for the Hound Dog, missile to be carried by the B-52G, none was spent. Nor was any money spent out of an additional $90 million directed for USAF's solid propellant second generation ICBM Minuteman.

However, the Administration said it got funds from other sources to speed up projects Congress specified.

There were missile cancellations too, hitting mostly USAF and Navy. Among the projects scrubbed were Navy's Chance-Vought Regulus II, air-breathing, supersonic missile capable of delivering a nuclear warhead 1,000 mi. or more. This left Navy with a submarine equipped for firing Regulus II, but no production stream of missiles. Regulus I, of which Navy has a modest stockpile, is out of production.

Another air-breathing missile which got the axe was Fairchild's Goose, a ground-launched diversionary vehicle, for which Fairchild had developed the J83 lightweight, high-thrust small turbojet. As the missile went down, so did the engine development.

There were no new funds in the Fiscal 1960 budget for more Northrop Snark air-breathing, long-range, high subsonic missiles, but orders placed with Fiscal 1959 funds indicated these would continue to flow into inventory for a while. The Snark is operational with SAC, has 5,000 mi. range.

Bell Rascal, a rocket-powered, nuclear tipped missile carried by B-47 bombers, also was eliminated, perhaps with an eye to modification of the airplane to carry the Hound Dog.

Army missiles cancelled included Dart, an antitank weapon, and Plato, a development project aimed at producing a mobile ICBM defense missile weapon system based on Nike Zeus.

Redstone missile, which had been fired from Cape Canaveral by Army soldiers, was to be given to Nato troops. Corporal, a liquid fuel ballistic missile, was deployed with the U. S. Army in Europe, but was to be succeeded by the solid fuel Sergeant. The solid fuel Pershing was coming along to replace Redstone.

A good clue to over-all missile status is contained in the budget when properly interpreted: the relationship between new obligational authority and expenditures, the ratio of constant level money to rising costs of research, development and hardware, and the designation of funds for procurement or development, test and evaluation.

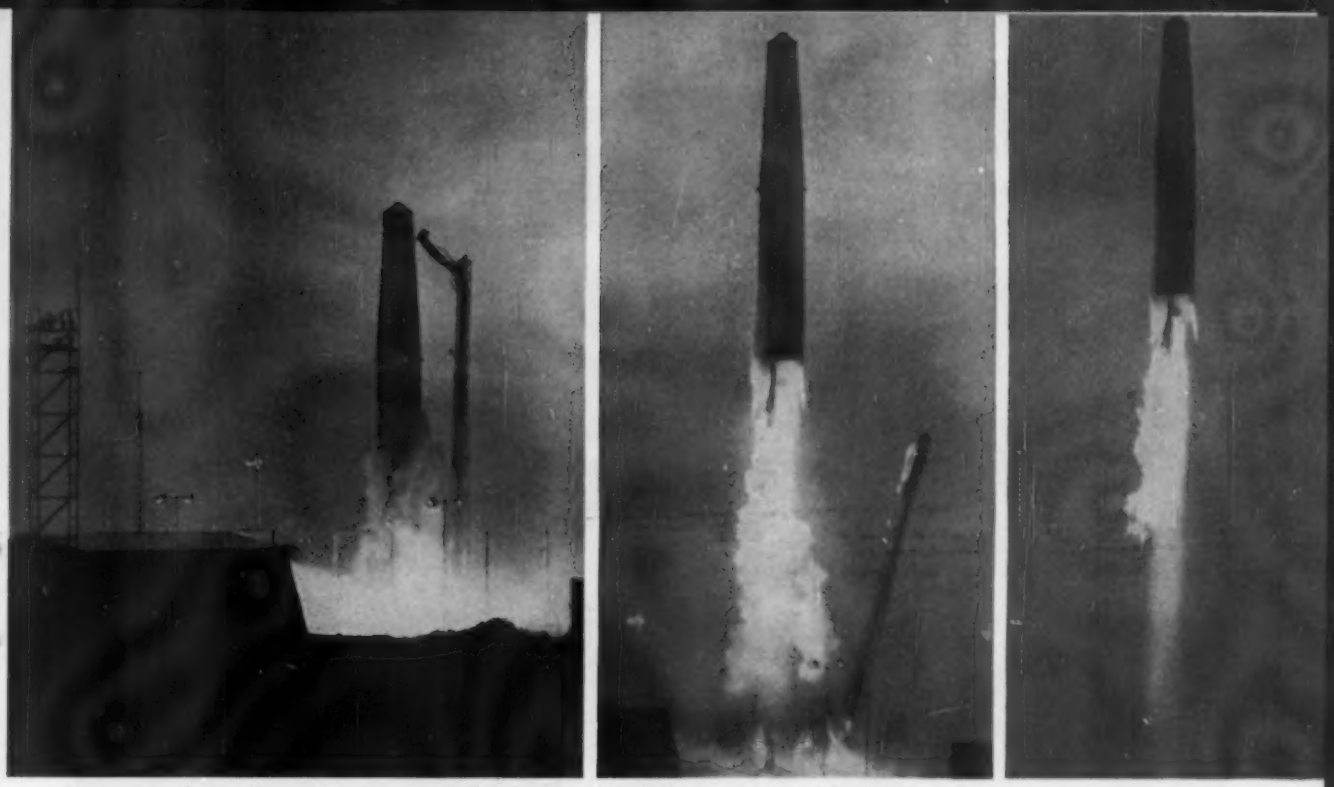
Administration succeeded in obtaining concurrence of the Joint Chiefs of Staff to the proposed Department of Defense budget as far as first public statements were concerned. However, as individual service chiefs were summoned to testify, they admitted individually that certain reductions from their requests caused them grave concern.

Here was how money requests went:

- **USAF** asked for $2.601 billion in new obligational authority for missiles. It said it intended to spend $2.768 billion for missiles, with the difference made up from unexpended but already appropriated money as mentioned earlier. There also was a request for $1.150 billion in new obligational authority for research, development, test and evaluation. Air Force expected to spend $1.011 billion for these purposes.
- **Navy** requested $645 million in new missile obligational authority; expenditures were estimated at $593 million. Research development, test and evaluation new obligational authority was requested at $971 million. Spending was to be $922 million.
- **Army** asked for new obligational authority for missiles of $302 million, said it would spend $463 million. Research, development, test and evaluation new obligational authority of $1.047 billion was asked, with expenditures set at $909 million.

USAF program in Fiscal 1960 for missiles was to include continued support of the Convair Atlas program, plus a 50% increase in Martin Titan and a 40% increase in Minuteman efforts. Since these funds include construction money, they do not represent purely development effort.

Later questioning of witnesses elicited these comments by Defense officials:



using operational ground support equipment. Roll-back shelter for missile is at left in initial photos.

• **Chief of Naval Operations** Adm. Arleigh Burke said he had asked a Navy budget of $14 billion, which was cut $2.5 billion. As a result, Burke said, most Navy programs including Polaris, had to be downgraded. Burke also said he was concerned over the limited funds provided for procurement of planes, missiles and ships.

• **Air Force Chief of Staff** Gen. Thomas D. White said he had asked a $20.6 billion budget but was allowed $18.6 billion. His chief concern was coming obsolescence of three-fourths of the Strategic Air Command, and with procurement of more modern weapon systems.

• **Army Chief of Staff** Gen. Maxwell D. Taylor said the Army estimate of $13.5 billion needed in 1960 to maintain required strength was cut to $9.9 billion, resulting in a cutback of all surface-to-air missile programs.

The first wing of strategic missiles is to be activated, which in this case undoubtedly means Snark. Atlas is too far away for a full operational wing unless greater than expected funding were poured into production, base construction and training effort.

There is little new money specified for procurement of the Douglas Thor and Chrysler Jupiter. However, it appears certain that these missiles will continue in production since the official quantity announced could not very well remain static.

Announced numerical levels are 80 Thors, 45 Jupiters. However, with four squadrons of Thors in England at 15 missiles per squadron, and a fifth Thor unit at Elmendorf AFB, Alaska, this number would make no allowance for deterioration, replacement, and most important, training firings. Likewise, if the three Jupiter squadrons received their full complements, that would amount to 45 missiles, exactly the specified total.

These are present totals contracted for; more of both will be built for use by The National Aeronautics and Space Agency and Advanced Research Projects Agency for space probes and other research work.

Production of Hound Dog is to be accelerated.

Mace Procurement

Procurement of the Martin Mace, an advanced version of Matador, and an improved version of the Boeing Bomarc are scheduled.

Development of an "advanced air-to-air missile for air defense" is to continue, which is the Hughes GAR-9, guided nuclear armed missile for use with the North American F-108 Mach 3 interceptor.

USAF's missile funds break down this way: procurement and production (all types), $1.092 billion; ground support equipment (all kinds), $535.1 million, and development, test and evaluation, $777.5 million.

For the Navy, the program will include mostly support of existing projects. One new one is making its appearance, the Bendix-Grumman Eagle, a long-range air-to-air missile. Navy won approval for this project despite Defense Department effort to get it to adopt the GAR-9.

Navy will continue procurement of Convair Terrier and Tartar missiles, the Bendix Talos and Philco Sidewinder. The Raytheon Sparrow III, with its greater explosive charge, its improved radar guidance system and range, is due to become operational this year, and so is the Martin Bullpup air-to-ground missile.

Also due for continued development is the Temco Corvus missile, an air-to-ground weapon which is designed to lock onto enemy radar and ride down the beam to destroy the transmitter.

For the Marines, procurement will continue of the Raytheon Hawk, ground-air missile for field deployment and use against low-flying aircraft.

Continued development for Polaris is slated, with part of the money Congress appropriated and earmarked for the program (as noted earlier) being carried over into this fiscal year's funds.

Navy also plans accelerated construction on the Pacific Missile Range.

For the Army, plans are to have 70 Western Electric Nike Ajax and Nike Hercules battalions operational by the end of Fiscal 1960.

Also slated are 73 guided missile battalions using such missiles as Corporal and Sergeant, plus three heavy field artillery missile groups.

Martin Pershing will continue in de-

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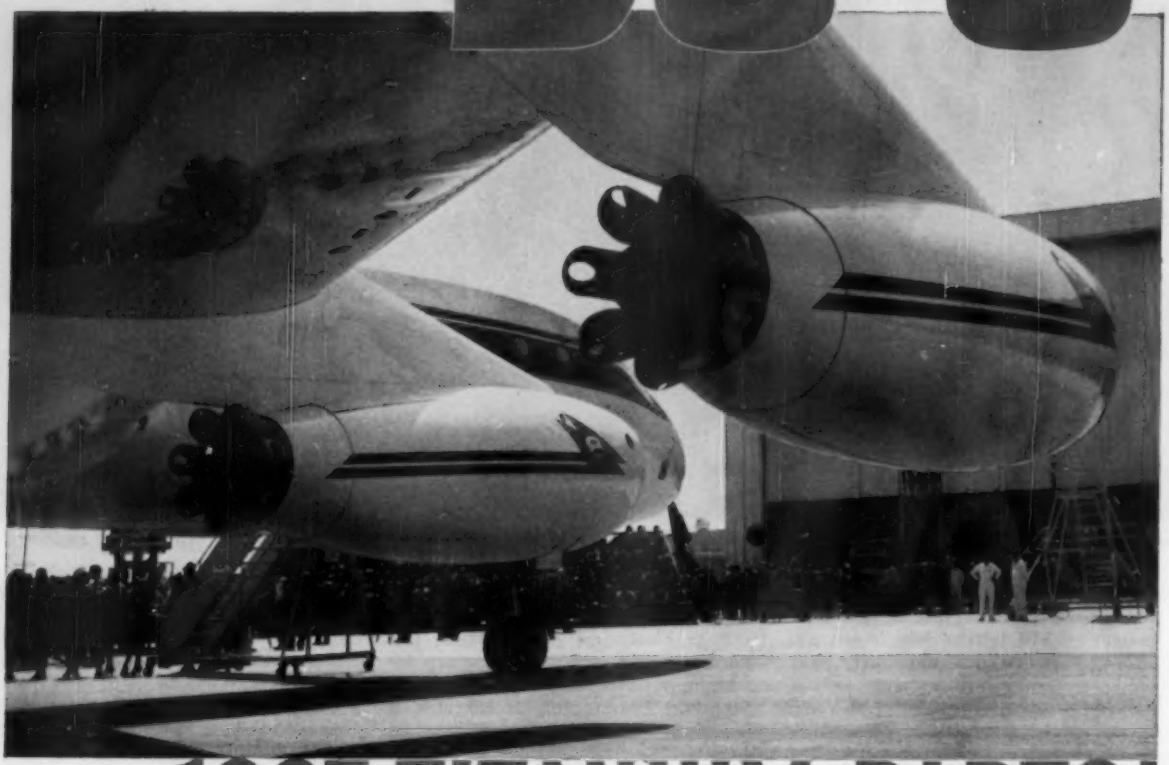
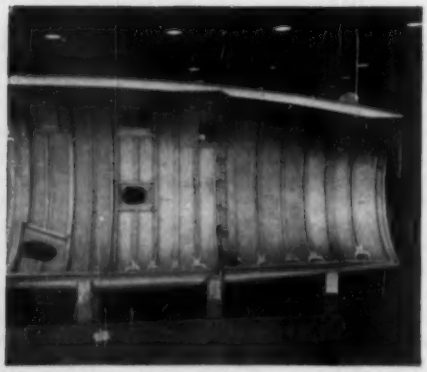


1667 TITANIUM PARTS!



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velopment and may enter the procurement category, since there is no new Redstone money.

Also to be continued is development of the Nike Zeus anti-missile system.

Here is the present status of major U. S. ballistic missile programs:

Atlas has been fired 20 times. This includes firings as Project Score, in which an Atlas hull went into orbit with a communications payload.

It has gone full range once, with all three rocket chambers operating—the two 165,000 lb. thrust booster chambers and the 65,000 lb. sustainer chamber. Early firings were of missiles with two booster chambers alone. Engines are by Rocketdyne Division of North American Aviation, Inc.

Of the 17 military firings, eight were considered 100% successful for the intended mission, eight were 50% successful for intended mission, one was rated at 10% successful. Adding the one missile for Score, there still are two missiles to be accounted for in the firing number.

It may be that these were unsuccessful space shots.

Atlas Sites

Atlas firings have been conducted at Cape Canaveral so far, but training firings at Vandenberg AFB, Calif. will start this year. At Vandenberg, operational type sites are being constructed rather than the research and development type installations at the Cape.

Much of Atlas activity now is in hands of SAC-Mike, the using agency, although Maj. Gen. Bernard A. Schriever's Ballistic Missile Division of the Air Research and Development Command continues as controlling agency. SAC-Mike will come into its own when first Atlas units become operational. This may happen late in calendar 1959 or early 1960. It also depends on the interpretation of the term operational. Currently SAC crews are in training, and have been present at launchings, static firings and other Atlas activities such as engine tests at Rocketdyne.

Due for Atlas also is a firm commitment for its use as the booster for the Sentry reconnaissance satellite. The missile booster also will be used in the NASA and ARPA man-in-space programs and other projects.

In addition there have been proposals by Convair to use the missile booster for basic equipment in a space station. Project Score indicated that the Atlas hull can achieve orbit, although the one obtained left much to be desired for true space work. If payloads are juggled and thrust of engines increased by a stretch in engine performance (booster chamber maximum growth potential is probably to thrust of 190,000 lb.), the

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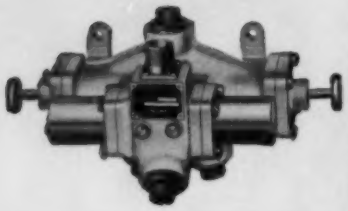
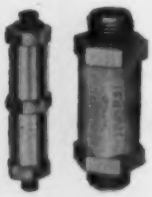


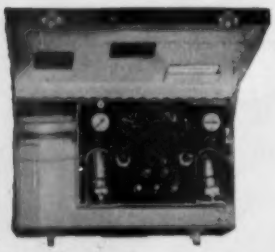
4-WAY SOLENOID SELECTOR VALVES—HYDRAULIC

3-WAY SOLENOID SELECTOR VALVES—HYDRAULIC

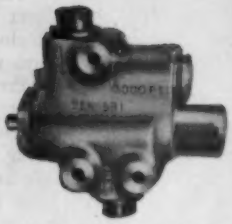
CONTROLLABLE CHECK VALVES—HYDRAULIC



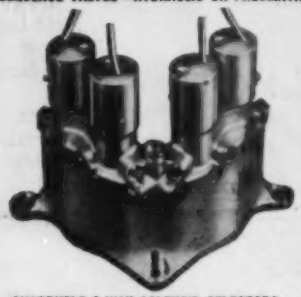
RESTRICTORS AND CHECK VALVES



PITOT-STATIC TESTERS



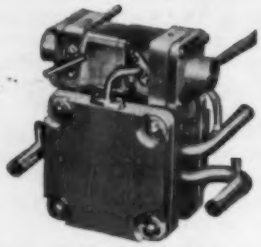
SEQUENCE VALVES—HYDRAULIC OR PNEUMATIC



QUADRUPLE 3-WAY SOLENOID SELECTORS—PNEUMATIC OR HYDRAULIC

POWER BRAKE VALVES—HYDRAULIC OR PNEUMATIC

4-WAY SOLENOID SELECTOR VALVES—PNEUMATIC



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missile hull can be thrown into a larger orbit.

There have been 32 Thor firings. Of these, seven were for special projects such as the three Air Force Pioneer space probes, three Thor-Able re-entry test vehicles, and one other, a Thor Bravo test vehicle.

Thor in Space

Also, Thor is used in the first Discoverer shot which, while listed as a strictly scientific NASA project, will feed back data to contribute to the Sentry program. So while technically it is a scientific space effort, it cannot help but contribute the major part of its information to military missilry and space systems.

Of the remaining 25 Thor shots, the last three were from operational rigs. One was strictly a "blue suit" (SAC) shot. This was the initial ballistic missile shot from Vandenberg AFB and served as the inaugural launching for the Pacific Missile Range.

At Cape Canaveral, two shots were conducted from operational equipment, i.e., using the launcher dry, the transporter-erector, launch control trailers and the rest. One of the shots at the Air Force Missile Test Center at Cape Canaveral was made the same day as the Vandenberg launching.

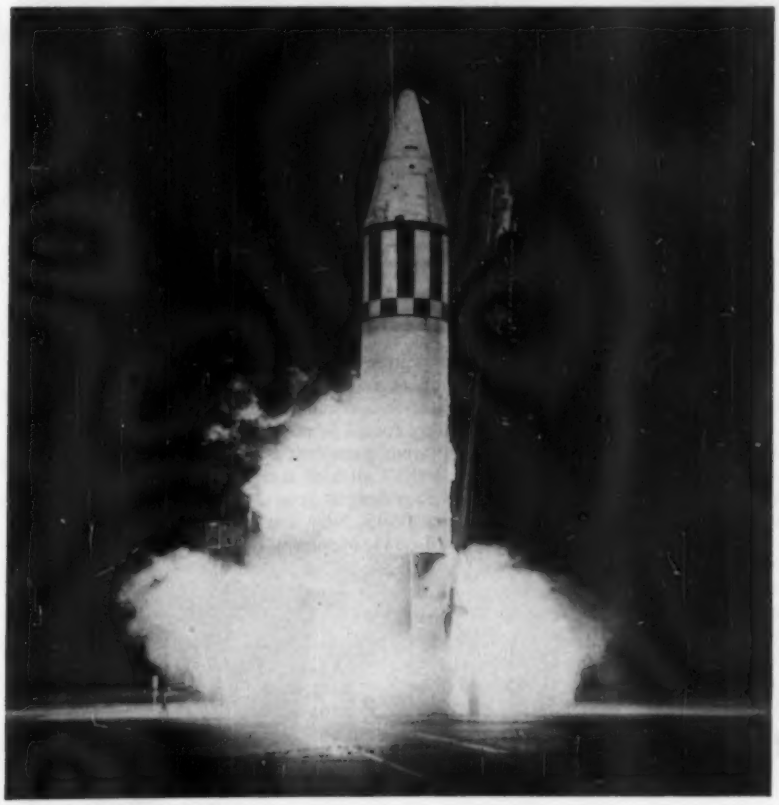
Thor training has been in progress for some time, including that for Royal Air Force personnel in Project Emily, the initial Thor overseas deployment. Although RAF missileers have not yet launched a Thor as a team, they have participated in and been present at other launchings, have traveled the complete Thor circuit including schooling at Tuscon, watched static firings at the Douglas Sacramento test facility, toured the production line at Santa Monica and watched engine firings at the Rocketdyne Propulsion Field Laboratory near Los Angeles, and at the major Thor engine production facility at Neosho, Mo.

Jupiter IRBM program has seen one operational configuration of the missile fired, this done early this year. All told there have been 14 Jupiters fired. (This does not include the so-called "Jupiter C" test vehicle.)

Jupiter Mobility

A mobility greater than that of Thor is claimed for the Jupiter system. Thor is described as "strategically mobile," i.e. all parts of the system can be air transported, but when deployed for firing emplacement the Thor unit is fairly well fixed. Easier producibility was claimed for Thor, however.

Jupiter elements, on the other hand, can be moved to fit a tactical situation or even a political one, its advocates say.



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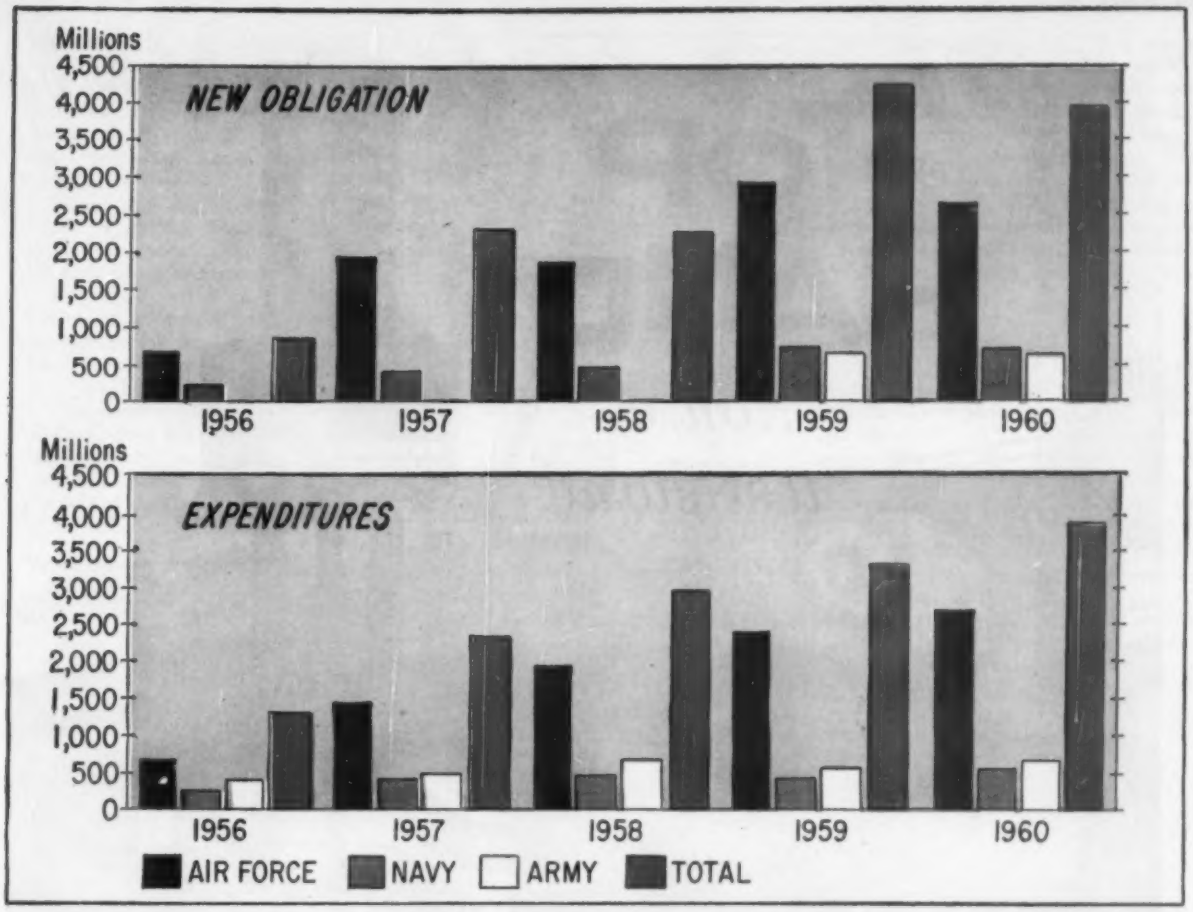


However, ground support equipment for one Jupiter launch emplacement is contained in 20 trailer vehicles, a larger number than Thor. Also, Jupiter fuels and receives its oxidizer from trucks, while Thor receives propellants from tanks which are off their strategic mobility wheels.

The Army-developed IRBM is launched from a slightly different type pad than that of Thor, mostly due to inherent differences in design of the missiles themselves.

The three operational Jupiter squadrons are the 864th, 865th and 866th. Of these, the 864th last December finished a training program which spanned one year, and is now engaged in a "phased deployment" to Europe. Second squadron, the 865th, has entered training, and with improvements in training techniques and progress on the learning curve, should be out next fall. Third squadron will start to assemble for training this summer.

Each Jupiter squadron has about 500 men, is basically similar to the Thor organization in that a launch area, a munitions area (warheads) and a receipt, inspection and maintenance area are used.

Jupiter squadrons have the same number of missiles as a Thor unit—15. Each launch emplacement handles more than one missile.

There have been Jupiters used in space projects also. Army's Juno vehicle was the third moon shot tried by the U. S. Where USAF's Pioneers were aimed at orbiting the moon, the Army tried for an impact with Juno. A malfunction also ended the Army lunar shot short of the target. More Jupiters are to be used in space programs.

Titan Firing

Titan ICBM has had two successful launches after several delays. The first was a 200 mi. flight which was primarily a test of first stage propulsion, composed of two booster thrust chambers by Aerojet-General with a nominal thrust of 150,000 lb. each. Second stage on this flight was a dummy, and water ballast was used. Second stage operational engine is an Aerojet product, with nominal thrust of 60,000 lb.

In addition, the Army Corps of Engineers, USAF's construction agent for such facilities, has asked for competitive bids for construction of the first Titan operational site at Lowry AFB, Denver.

This will be a hardened underground facility, with an elevator to lift the missile to the surface for firing. The facility will house one squadron of Titans, will have nine separate underground emplacements or silos, and is scheduled for completion 730 days after contract award. USAF has released $45 million already to get construction under way.

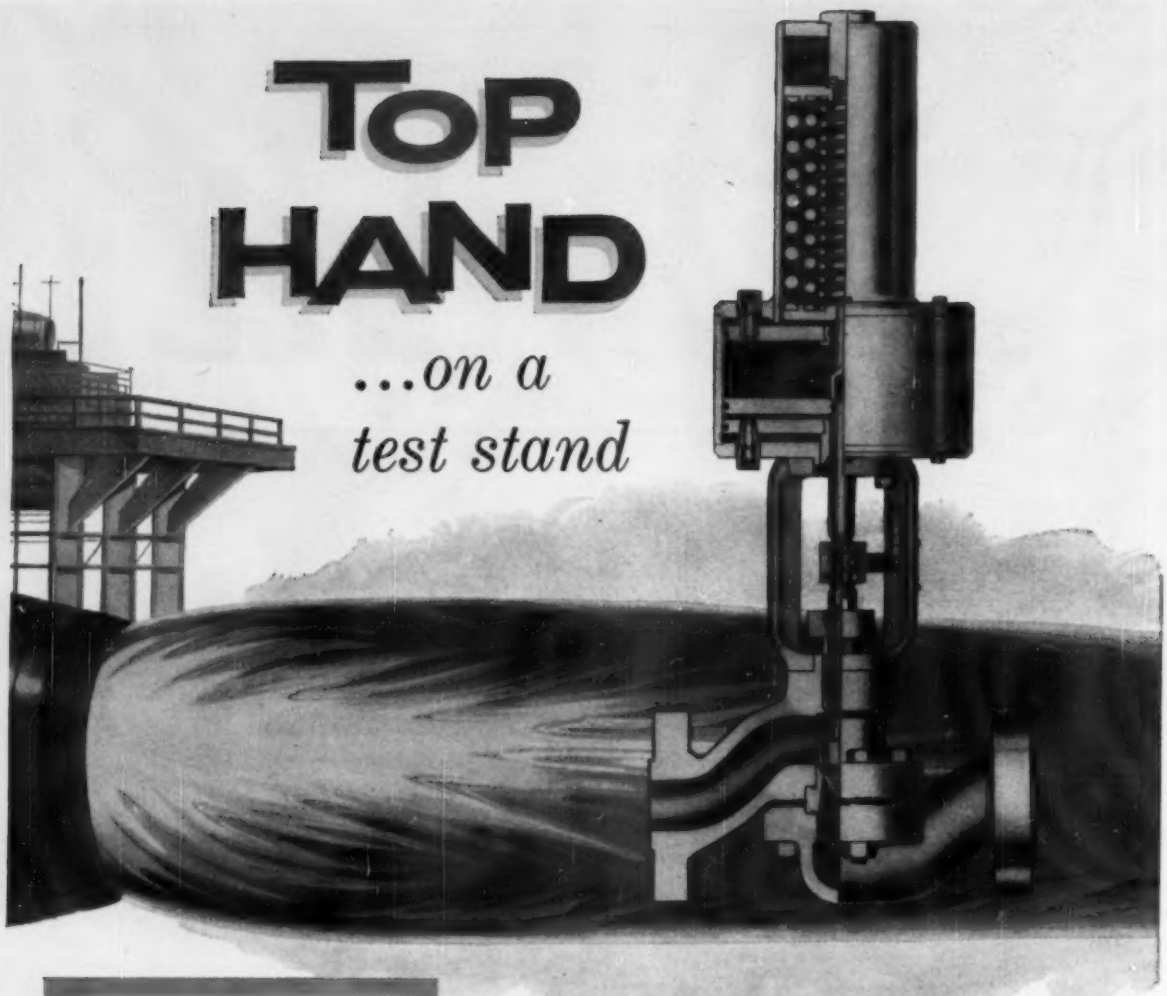
Also, the Corps of Engineers has asked for bids on construction of three silos at Vandenberg AFB. The mission at Vandenberg is primarily training, but operational capability will be built into the facility.

Lowry facility will consist of nine silos 163 ft. deep and 40 ft. in diameter, with elevators to lift the weapons for launch; three storage silos 73 ft. deep, 27 ft. in diameter; three control centers, spherical in shape, with a 51-ft. radius and inside height of 35 ft. 9 in. at the center; three spherical powerhouses with a 62 ft. radius, center inside height of 46 ft.; nine equipment silos 62 ft. deep and 40 ft. in diameter; nine propellant terminals 47 ft. deep, 37.5 ft. in diameter, and six antenna terminals 68 ft. deep, 27 ft. in diameter.

Intent is that maintenance and checkout of most Titan systems can be done in silos or equipment terminals which

TOP HAND

...on a test stand



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are 30 to 40 ft. away and interconnected by tunnels. Each of the nine firing silos has its separate equipment and propellant terminals so it can function independently during missile preparation. Silos are separated by several hundred feet of earth.

Firing silos are in groups of three each. A separate control center and ground guidance system are provided for each group of three.

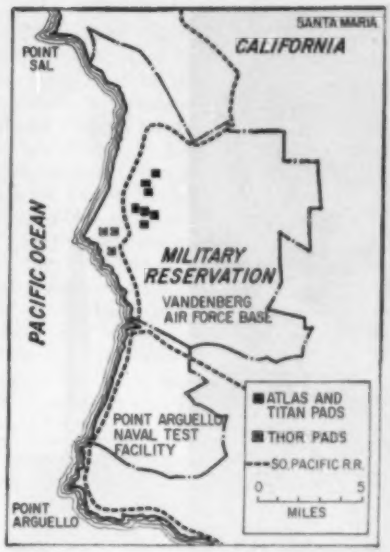
Last crew action in a silo before launch is to prepare the missile for fueling, which is done automatically. Missile is fueled before elevation to firing position.

Command guidance enables control of Titan until thrust termination. Later versions may include an all inertial guidance, and with ground control eliminated, enable all nine missiles to be salvoed.

Vandenberg Layout

Vandenberg complex will be similar to the Lowry facility except that it will be based on a group of three missile silos rather than nine. There will be other exceptions due to the training mission, but operational capability will be retained.

Speed-up in Titan testing is expected by Ballistic Missile Division due to several factors. One is that Titan is airlifted to Cape Canaveral after almost



complete checkout and exercise of the vehicle at Martin's Denver plant. At the Missile Test Center, the missile needs minimum work in readying for launch, according to BMD. Also, should a missile encounter trouble which requires a return to the factory, a few hours flying time either returns the malfunctioning weapon or replaces it with another.

In addition, there naturally will be a better learning curve for Titan due to experience backlog gained from the Convair Atlas program in several areas.

Navy's Polaris fleet ballistic missile, designed for launching from underwater, is well into its test firing program, which will be accelerated this year. Meanwhile, work is advancing on the first atomic-powered submarine to carry Polaris. This boat, the George Washington, is expected to be commissioned in 1960.

Polaris Series

A firing conducted at Cape Canaveral last September started the program, testing of AX vehicles, and will be followed by the AX-1. AX is an almost exact approximation of the Polaris external configuration. The program will continue most of this year. The AX uses an Aerojet-General powerplant, where earlier vehicles had used Thiokol rockets; these were to check out components, systems and such things as thrust termination and method of flight control.

Also, AX uses an electrical programmer to tip the vehicle for flight over Atlantic rather than an operational guidance system.

Twenty-one successive, successful firings, covering a period of about 1½ years, preceded the first AX shot in September.

Other activities in the test program

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include use of the USS Observation Island, a vessel which has been modified to do almost everything a Polaris submarine will do except submerge. Ship will be at Cape Canaveral soon, shortly thereafter will go to sea to fire missiles. Ship work will be a transition from land-based installations at the missile test center to full submarine operations.

Off San Clemente Island, Calif., Operation Pop Up has been run by Navy. In this dummy missiles are shot upward from ocean floor using a launch tube. Tubes are loaded at the Navy's Long Beach facility, towed to sea and sunk, then anchored to a concrete block on the bottom. After the dummy is launched, a net system is triggered which catches the dummy when it falls back to the water, protecting the launcher and aiding in retrieving.

Polaris support equipment includes SINS, Shipboard Inertial Navigation System, and other navigation systems, since the most accurate determination of the submarine's position is required for programming the missile's guidance before sending it on its way.

Although operational configuration dimensions are frozen, improvements expected in propellant efficiency, warhead size, guidance and systems are anticipated and provided for in the Polaris design.

A second generation intercontinental ballistic missile also is coming along—USAF's solid propellant Minuteman.

Intended to be a weapon left in an isolated hole in the ground and remotely fired when needed in a retaliatory mission, Minuteman is an extremely simple concept which entails a most sophisticated and elaborate engineering effort to achieve the desired simplicity of the weapon itself.

Most critical part of Minuteman is the ground environment and its many ramifications. Reliability is the key to instantaneous reaction with Minuteman, and part of the weapon's inherent advantage is the ability to be left all alone in its hole, far from civilization and population centers.

A real problem in Minuteman development is who shall develop the ground environment. Indicative of the problem is the fact that with the Thor IRBM, ground equipment accounts for 87% of the weapon system's cost, and the ground equipment is relatively intricate. With Minuteman, cost of ground support equipment may well go higher proportionally, and how to place development of this portion of the weapon system properly is a delicate matter.

In any case, Ballistic Missile Division is the weapon system manager, with systems engineering and technical direction furnished by Space Technology Laboratories, so that major decisions will be made here.

Much time might be saved and cost somewhat reduced if the proper decision is made concerning placement of the ground environment contract or contracts. Present team might be able to do it better due to knowledge of missile and systems. Or a brand new contractor might be able to do it better due to lack of preconceived ideas.

Testing of components is under way in the Minuteman program. Tests related to thrust control and thrust termination have been conducted, and these parts of the problem, considerably different with solid propellant engines than with liquid, are well in hand.

Minuteman funding is a sensitive area—in view of funds appropriated by Congress but not spent by the Department of Defense. Money is available for spending on the program, money which could bring it along fairly swiftly and enable the system to reach operational capability in a shorter time span than originally intended. Exactly what use will be made of available funds remains to be seen.

Minuteman has been projected to a constant envelope that permits growth to occur naturally, requiring no major redesign with improvements in state-of-the-art in propulsion, warheads, etc. Growth is allowed in the design to reach the weapon's projected capabilities.

Future advancements in missile and space technology are largely dependent on activities today in operation research. At Lockheed, operations research scientists explore future programs, evaluate the objectives and requirements of new proposals, establish parameters for the most effective procedures, determine specifications, perform preliminary design and analysis and originate proposals for both immediate and long term development.
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Studies include: game theory; linear programming; decision theory; statistics applications; logistics; cost analysis; industrial economics; electronic systems; operations engineering; military operations; development planning; and weapon systems operational analysis.
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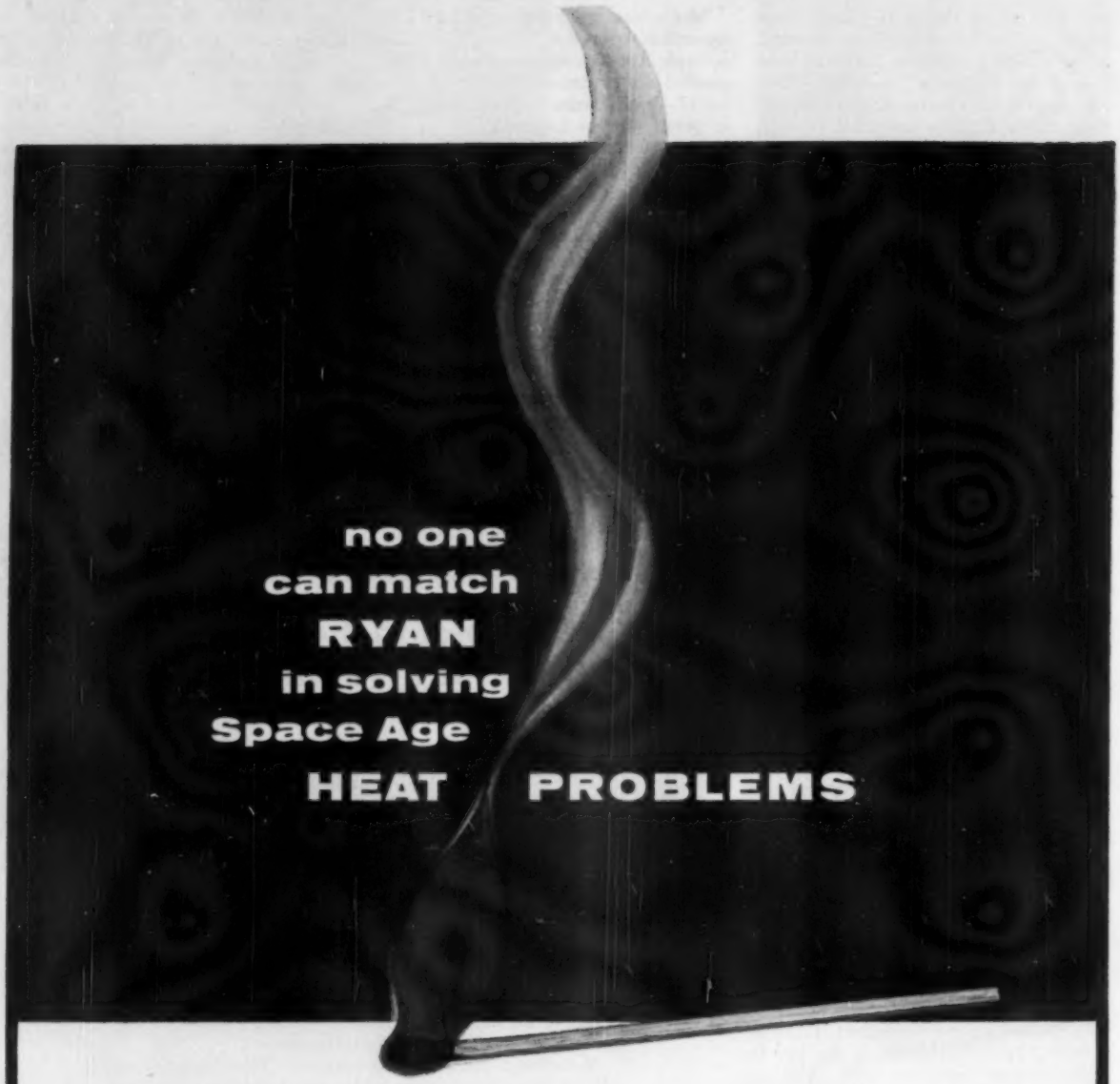

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Missile Support Equipment Role Grows

By Barry Tully

Missile ground support will continue to command an increasing share of defense spending, with $1.1 billion budgeted in Fiscal 1960 compared with estimated Fiscal 1959 expenditures of $900 million and not including some research and development money which will go to support equipment producers.

Approximately one-half of the ground support total will go for electronic checkout and launch control systems. Missiles receiving the biggest share of the Fiscal 1960 appropriations will be the Convair Atlas intercontinental ballistic missile, which will become operational in 1960, and the Martin Titan ICBM, slated for faster development.

Increasing in direct proportion with budget expenditures is the competition for missile ground equipment contracts. Prime missile contractors look upon the production of support equipment as an area where they can regain some of the volume lost to the guidance, propulsion and nose cone producers. Some traditional equipment manufacturers feel that they, although perhaps better suited for support equipment production, are forced into intense competition for the remaining ground support dollars.

Simplicity Emphasis

Trends apparent in the development of missile support equipment include the standardization and combining of functions of missile checkout gear and simplification of missile ground handling equipment.

Standardizing and combining of checkout systems will serve two purposes. It will reduce the clutter of support equipment now surrounding a missile launch site and it will enable relatively untrained personnel to perform missile checkouts. The Army reports development of a missile checkout system based on a dial telephone principle in which a soldier can dial a coded series to perform a particular system checkout. The Air Force also is studying simplification of missile prelaunch checks. Some engineers fear that overemphasis in this direction will result in checkout systems that are impossible to maintain.

Simplification trend in regard to missile handling equipment is the result of the development of oversophisticated, unreliable equipment and some expensive gear which priced itself out of consideration.

Some of these support trends will be apparent at the first Atlas ICBM base under construction at Vandenberg AFB, Calif. Titan ICBM launch site, now under development at Vandenberg, will be the first hard base ICBM site, using "hard" in the sense of an underground site.

The application of the systems approach to missile ground support has resulted in greater flexibility and reliability in support equipment. A few of the companies involved in the systems concept handling equipment are the Fruehauf Trailer Co., Food Machinery Corp., Goodyear Aircraft and North American Aviation.

American Machine & Foundry, in its proposal for the Titan ground environment contract, championed the cause of using commercially available handling equipment whenever possible. The idea is that not only would the equipment be far less expensive but missile people would benefit from the experience of the commercial equipment handlers.

Main piece of handling equipment to be used with the Titan will be a modified commercial crane. Unit will be used to lift the missile from the transporter, erect the missile and service the underground silo. Hard base for the liquid propelled Titan, with its necessary fueling and elevating provisions, will be a far more complex affair than the silos envisioned for the solid propellant Minuteman which will be fired inside the silo.

The role of ground support equipment for solid propellant missiles remains a question to many equipment manufacturers. The simplicity concept of the solid weapons implies an independence of ground support equipment. The Minuteman, however, as described in AVIATION WEEK (Jan. 19, p. 68), will rely heavily on a complex ground environment system to provide a push-button retaliation capability.

Smaller tactical solid propellant mis-

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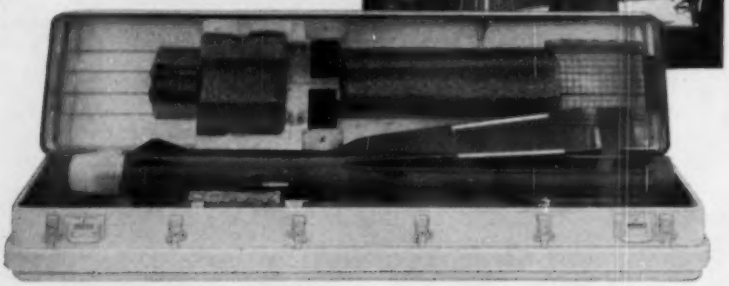

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siles, will require extensive ground support. The trend appears to favor electronic support producers. Checkout systems giving both go-no-go readouts and pinpointing trouble spots will still be essential with the newer weapons. Fire control systems for solid missiles is another area where work will be intensified.

Handling of the larger solid weapons will create load challenges for the transporter and erector companies, presently handling only liquid propellant missiles which are fueled in the firing position.

Support Problems

A problem that has plagued missile development is liaison between the many support equipment suppliers, the prime contractors and the military. Streams of changes flowing from the missile designer have varying effects throughout the missile ground support system. Both prime and support equipment manufacturers agree that steady improvement is being made in this area, chiefly through better communications between companies and by permitting equipment people to get an earlier start than had been the case. Still, this continues to be one of the most difficult areas.

Another trouble spot in the ground equipment field is the collating of feedback information from field units. Field personnel feel that no heed is paid to their trouble reports sent to the systems contractor. Producers reply that many reports conflict so much that it is impossible to draw conclusions from them.

One reported cause of this is that manufacturer's bench test equipment and field checkout gear vary in their respective readouts. These variations, particularly in respect to electronic systems, can cause significant misinterpretation as to the causes of malfunction.

Continuing demands are being made on electrical power supply producers to supply smaller, lighter, more precise electrical power supply units. Considerable advances have been made in the field of load-compensated static exciters and load-sensing generators. Transistorization of test equipment has in some cases eased the over-all load requirements; however electronic computers and guidance checkout equipment continue to demand the utmost in precision power.

Significant improvement in the area of missile fueling is noted. Cryogenic ball valves have demonstrated their effectiveness in handling liquid oxygen and liquid nitrogen. Manufacturers say that lack of precision in the manufacture of cryogenic valves caused a large percentage of early missile failures. Improved hosing and pumps also are contributing to successful firings.

CONVAIR 880 jet transport takes off on its first flight.

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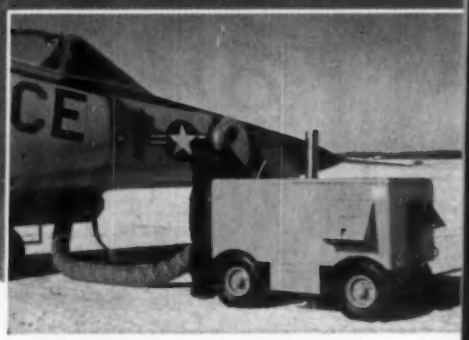

HERMAN NELSON portable heating and ventilating unit for the F-102. Each system presented a different problem; each required specially designed equipment. For each, Convair turned to AAF Defense Products Division.

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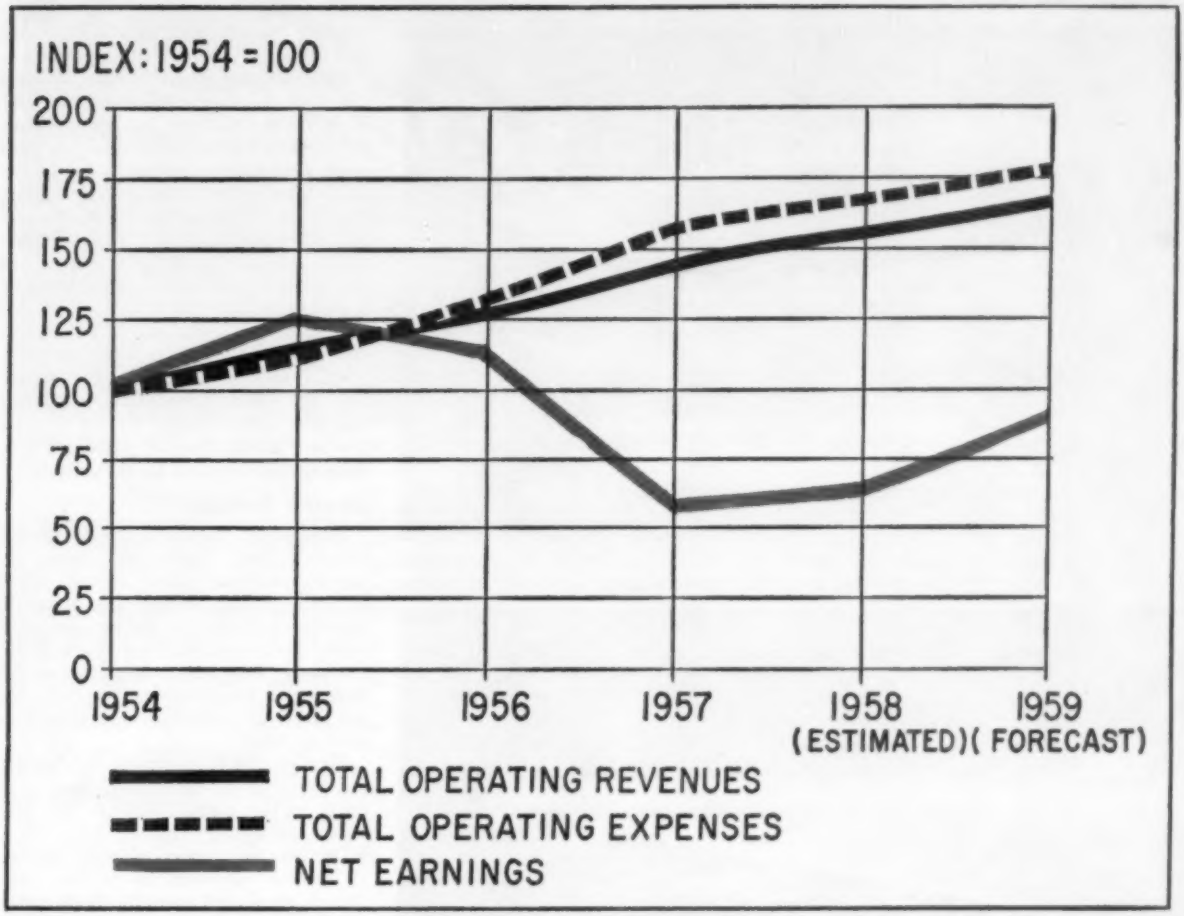


Resurging Trunk Traffic Won't Be Cure-All

By L. L. Doty

Washington—Prospects that the trunkline industry will return to its historic growth pattern after suffering its first traffic decline in 10 years during 1958 now appear bright.

General optimism throughout the industry over the renewed expansion of airline traffic during the next 12 months ranges in forecasts from a 3% increase over 1958's revenue passenger miles to a 10% rise. However, such optimism is confined to revenue and traffic categories: most observers are convinced that the industry's chances of escaping this year from the two-year-old profit squeeze are slim.

An AVIATION WEEK survey now indicates that net earnings for the trunkline industry will reach $43 million this year compared to a $40 million profit last year and a $27 million net figure in 1957.

Although this 43% improvement is an encouraging sign, most airline officials are fully agreed that the amount falls far short of the profit margin the industry needs to back its $3 billion re-equipment program, including spares, now under way.

In addition, industry leaders are quick to point out that the amount is as large as it is only because of the strong earning power of four carriers among the 12 trunklines: American, Eastern, Northwest and United.

Airline Profits

American last year showed an estimated net of $13 million, Eastern $7 million, Northwest $5.5 million and United $14 million. Balance of the airlines reported either substantially smaller profits or net losses so that the bulk of the industry's showing last year was made up by the earnings of these four.

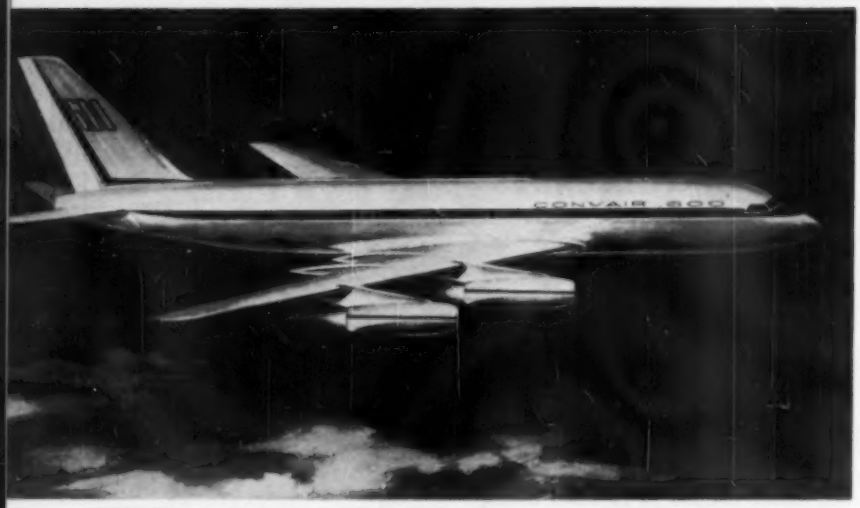
Forecast for total operating revenues for 1959 is set at $1.6 billion by AVIATION WEEK.

This compares with an estimated gross revenue for the trunkline industry of $1.5 billion last year. Expenses are expected to climb from an estimated $1.45 billion in 1958 to about $1.55 billion this year.

All forecasts are based on the theory that the general economy will go through this year without any spectacular setbacks and that the gross national product will continue to rise during the year to reach the $470 billion mark by December.

The forecasted profit figure is based on the assumption that most carriers will cling to a Civil Aeronautics Board depreciation policy calling for an across-the-board seven-year depreciation with a 15% residual value for aircraft and spares. Financial analysts say the Board policy, which is no longer a regulation because of a Supreme Court refusal to uphold the ruling, has the effect of

PARADE of new jet transports now includes the first Boeing 707-320 Intercontinental, powered by Pratt & Whitney JT4 turbojets. Rolls-Royce Conway will power 420 series.



FARTHEST away is the Convair 600, on order by American Airlines (above). It will have General Electric turbofan engines. Boeing 707-120 in Continental markings (below).

inflating profits and creating "paper earnings."

The industry generally has not been too eager to exude enthusiasm over the prospects for the year for fear of leading the Civil Aeronautics Board to conclude that a fare increase is no longer justified. On the other hand, it must demonstrate financial health to bankers and investors in order to capture long-term loans in a tight money market and to lay the ground for an expansion of equity bases.

The past year's activities have been sufficiently slack to prove the need for a fare increase. Whether the recent reversal of the downward traffic trend will bear any influence on the Board's decision in the general passenger fare investigation remains to be seen.

Investor Interest

Meanwhile, the introduction of the turbojet and turboprop transports coupled with a sudden upward spurt of traffic during January has attracted investor interest in airline common stocks listed on the New York Stock Exchange. Reaction among professional traders and large bankers, however, has not been as enthusiastic despite the obvious trend.

Here are the chief reasons behind the rosy views of the trunklines—sharp contrasts to the dismal outlook that prevailed throughout most of last year:

• **Decline in traffic** volume during 1958—now estimated to be less than 1%—is attributed generally to the economic recession which retarded business activity during the first nine months of 1958. Most economists now predict that the current upswing in general business will continue throughout the year. This recovery is expected to be reflected by a resumption of airline traffic growth.

• **Major labor issues** have been resolved so that the airlines will not be faced with a disrupting flurry of drawn-out strikes like those in December which toppled trunkline revenue passenger miles 12% from the previous December and sliced available seat miles by 25%.

• **Impact of jet transport** service is expected to generate new traffic. Expanded promotional and advertising campaigns designed to sell the new turbine equipment to the traveling public are prompting both manufacturers and the airlines to compete with similar programs keyed to air travel in general. Outlay for advertising and publicity during 1959 will establish an all-time high for the industry.

• **Elimination of round-trip,** open-jaw and circle-trip discounts and the reduction of the family plan discount in October will boost revenues during 1959. Although the industry continues to call for fare increases in excess of 12% as

UNITED AIRLINES' first Douglas DC-8 makes its initial flight. Deliveries will not begin until late this year.

a means of restoring a healthy profit margin, chances are now strong that the Civil Aeronautics Board will either vote against any fare hike or will grant an increase of no more than 3%. Decision in the Board's general passenger fare investigation will be issued before July 1.

• **Traffic** will be generated by new travel-promotional plans now being devised by the industry. One of the first of the new type programs, which are keyed to marketing techniques, is Capital Airlines' plan to sell vacation packages to large industries for employes who wish to pay the costs on a wage deduction basis.

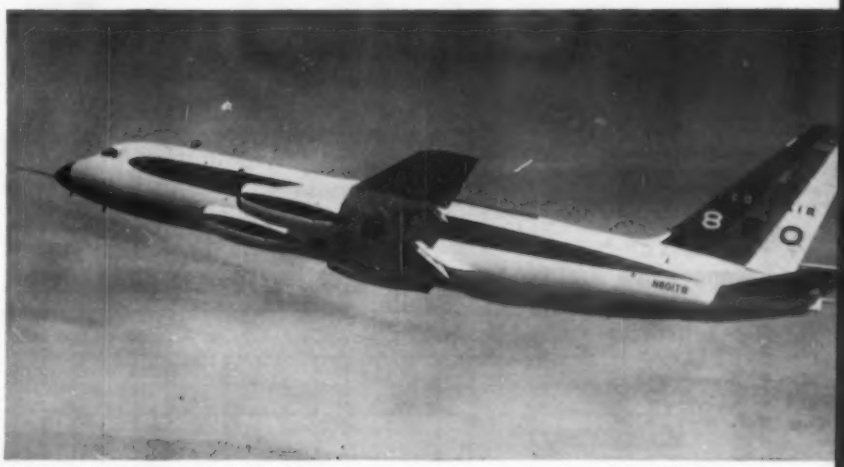
Jet Fleets Grow

Major event of 1959 will be the expansion of turbine-powered equipment fleets on domestic routes throughout the U.S. National Air Lines began Boeing 707 turbojet service on routes between New York and Miami in December through an equipment-lease arrangement with Pan American World Airways.

American Airlines started nonstop New York-Los Angeles Boeing 707-120 and New York-Chicago Lockheed Electra service in January. During the first 15 days of operation, the American Boeing recorded a 99.2% load factor, testifying to the popular appeal of the turbojet transport. During the same period, Electra load factors were 86% on westbound flights, 80% eastbound.

Eastern was forced to delay inauguration of its Lockheed Electra service from Dec. 1 to mid-January because of a 39-day strike shutdown. The carrier is accepting delivery of its 40 Electras at a rate of one a week and is now operating the turboprops on routes from New York to Miami, New Orleans and Houston. By the end of the year, U.S. scheduled airlines will have a total of 78 turbojets and 210 turboprops in service.

Introduction of the jet era in the



CONVAIR'S 880 was the latest of the jet transport entries to make its first flight.

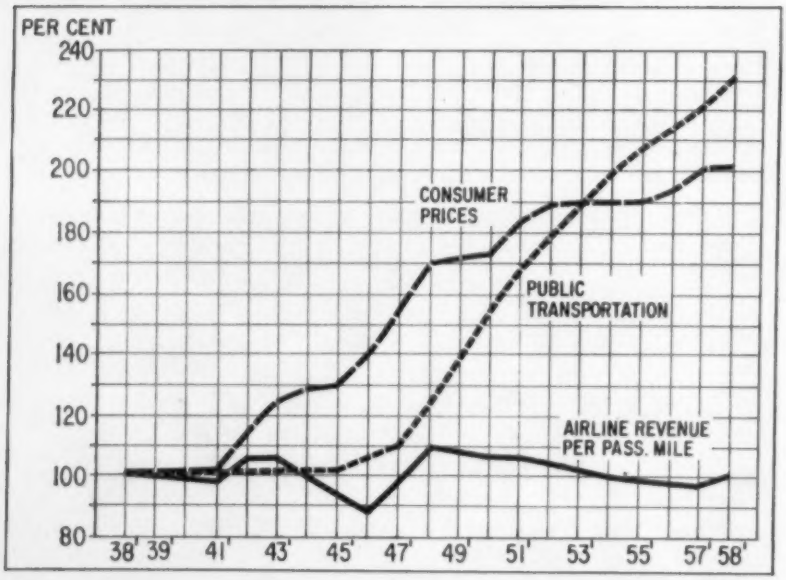
LOCKHEED ELECTRA turboprop has gone into service with American and Eastern airlines.

Comparative Direct Operating Costs

(Cents per U. S. domestic plane-mile, 12 mos. ending June 30, 1958)

	Flying Operations	Direct Maintenance	Applied Maintenance Burden	Depreciation Charges	Interchange Aircraft Expense	Total Direct Operating Expense
DC-3	37.38	13.88	6.95	2.97	....	61.18
CV-240	45.76	19.47	17.41	6.56	....	89.20
CV-340	44.63	17.33	12.02	19.88	0.98	93.94
CV-440	45.07	16.31	7.13	25.74	....	94.25
M-202	50.20	22.18	10.65	11.46	....	94.49
M-404	44.11	19.96	10.62	5.07	1.02	85.78
DC-4	59.81	27.98	14.17	0.76	....	102.72
DC-6	56.39	23.96	18.14	5.72	6.81	111.02
DC-6A	62.54	14.58	14.83	25.51	....	117.46
DC-6B	63.38	17.36	13.42	19.35	6.94	120.45
DC-7	64.62	20.75	17.31	31.98	3.71	138.37
DC-7B	68.37	26.63	10.69	36.65	....	142.34
DC-7C	64.22	24.06	12.05	28.74	....	129.07
L-049	75.83	32.83	16.99	13.65	....	139.30
L-749	68.44	27.27	16.72	5.98	....	118.41
L-1049	77.04	32.16	17.69	9.91	....	136.80
L-1049C	77.96	33.46	12.87	21.81	....	146.10
L-1049G	73.74	34.39	16.96	34.12	....	159.41
L-1049H	84.39	19.00	13.66	36.63	....	153.68
L-1649A	68.28	25.23	19.55	38.11	....	151.17
VV-745	41.15	17.98	8.90	17.62	....	85.65
C-46	39.96	22.50	11.64	15.48	....	89.58
Ladestar	36.22	17.30	18.92	0.72	....	73.16
B-377	83.98	44.43	20.63	4.20	....	153.24

Comparative Airline Unit Passenger Revenue Trend



U. S. Helicopters Engaged in Scheduled Air Transportation

OPERATOR	B47G	S58C	S55	S51	V44B	TOTALS
Chicago Helicopter	3	5	1			9
Los Angeles Airways			5	2		7
New York Airways	1				5	6
TOTAL HELICOPTERS	4	5	6	2	5	22

U.S. was marred by the crash of an American Airlines Lockheed Electra during the final approach of a landing at LaGuardia Field in February. The following day, a Pan American Boeing 707-131 plummeted into a steep spiral dive from an altitude of 35,000 ft. to 6,000 ft. before the crew was able to pull the aircraft back into level cruise position.

However, latest traffic figures from American, Eastern and National give no indication that the traveling public is shying away from the newer equipment because of these incidents. Carriers now contend that the new aircraft will probably be directly responsible for a return to a normal growth pattern although no one is so optimistic as to predict that the historic 13-18% annual increase will ever be restored.

Traffic Slowdown

Revenue passenger miles for the year were down .3% compared to a 13.2% increase recorded for the 12 months ended December, 1957. Drop was due primarily to a 4% drop in first-class revenue passenger miles since coach revenue passenger miles climbed 5.6%, an insignificant rise compared with the 18% increase recorded in this category during 1957.

At the present time, an AVIATION WEEK forecast for 1959 indicates that revenue passenger miles will show an increase of about 7% over 1958. Biggest increase is again expected in the coach category during the year.

Return on investment in 1959 is expected to show only a slight increase. In 1958, return on investment—net profit plus interest on long-term debt as per cent of net worth plus long-term debt—was 5.2%.

Return margin on sales for the year was 3.5%. Return margin on sales is based on net profit plus interest on long-term debt as per cent of operating revenues.

Traffic Progress

Further progress toward the elimination of traffic jams in the overcrowded airways is expected with the final organization of the Federal Aviation Agency. The new agency, which absorbs the Airways Modernization Board, Civil Aeronautics Administration and the safety rule-making functions of the CAB, became law in August when President Eisenhower signed the Federal Aviation Act of 1958, approved earlier in the month by Congress.

Elwood R. Quesada was named administrator by the President in October and the FAA became a fact Jan. 1. Quesada began naming assistant administrators and office chiefs shortly after accepting the appointment and the new organization is now geared to take over the operation and maintenance of air-

ways and air traffic control facilities.

Strikes that grounded Capital, TWA, Eastern and American airlines late last year resulted in a mutual aid pact designed to provide financial aid among six airlines in the event of a strike. The Board found the agreement was not adverse to the public interest and tentatively voted its approval of the plan.

Pact Opposition

The agreement was signed by American, Capital, Eastern, Pan American, TWA and United. It is not considered likely that the list of members will be increased since a number of airline heads, not signators to the pact, are vehemently opposed to the program. However, all but two airlines are supporting a similar arrangement that calls for financial protection through coverage by insurance groups such as Lloyds of London.

Publication of a report on the airline industry prepared by Dr. Paul Cherington for Quesada, then special presidential aide for aviation, drew widespread interest to the financial problems of the airlines. Cherington's recommendations that new markets should be tapped by the airlines through the use of promotional fares and other devices has been strongly endorsed by the industry. Most observers view the report as critical of Civil Aeronautics Board regulatory activities in financial matters.

Major problem facing the industry now appears to be the financing of new equipment. Most of the industry has made arrangements for long-term loans to cover at least part of the cost of converting to turbine equipment. However, the prospects that all carriers within the industry will survive the transition are, at this time, grim.

A number of observers anticipate sweeping changes in the traditional structure of the industry's route makeup and are forecasting that mergers or even bankruptcies may eliminate some familiar corporate names from the industry's roster. Those carriers which have consummated loan agreements with banks and insurance companies are looking to retained earnings, equity sales, returns on the sale of piston-engine equipment as means of raising funds to meet the demands of jet operations.

Equity Problems

Unless the industry is able to break the current profit-squeeze, chances of increasing capital by retaining earnings are poor. And despite the interest in airline common stock on the New York Exchange, bankers and financial experts are not yet certain that the industry can successfully undertake any equity financing at this stage of the game.

The used-plane market continues to

Domestic Trunkline Traffic Activity During 1958 Compared to 1957

Month	Passenger Revenue Miles (In Billions)		Available Seat Miles (In Billions)		Load Factors	
	1958	1957	1958	1957	1958	1957
January	2.07	1.90	3.51	3.14	58.95	60.46
February	1.72	1.70	3.08	2.89	55.76	58.98
March	2.00	2.01	3.42	3.31	58.55	60.70
April	2.03	2.01	3.39	3.22	59.80	62.30
May	1.96	2.02	3.50	3.32	56.13	60.70
June	2.28	2.33	3.63	3.32	62.81	70.23
July	2.24	2.25	3.75	3.46	59.70	65.14
August	2.38	2.35	3.77	3.56	63.16	65.97
September	2.10	2.10	3.60	3.42	58.24	61.32
October	2.10	2.02	3.49	3.45	60.21	58.43
November	1.78	1.79	2.90	3.24	61.38	55.28
December	1.77	2.03	2.64	3.51	67.16	57.81

Domestic Trunklines—Estimated Traffic and Revenues 1957, 1958

TRAFFIC	1958	1957	Per Cent Increase
	(000 omitted)		
Revenue Passenger Miles	25,539,400	25,250,100	1.1
Mail Ton Miles	105,200	98,800	6.5
Express Ton Miles	47,300	44,400	6.7
Freight Ton Miles	234,600	220,500	6.4
Revenue Ton Miles	2,846,600	2,798,900	1.7
REVENUES			
Passenger	$1,380,900	$1,287,200	7.3
Mail	35,800	33,800	5.9
Express	14,200	14,700	−2.9
Freight	55,400	49,900	11.1
Other	38,500	34,100	12.9
Total Revenue	1,524,800	1,419,600	7.4
Total Expenses	1,464,600	1,377,600	6.3
Net Operating Income	60,200	42,000	43.1
Net Profit (after taxes and interest)	30,000	27,000	11.2

Total Traffic on U. S. Common Carriers

	1957 (ACTUAL)		1958 (EST.)	
	Passenger-Miles (millions)	Percent of Total	Passenger-Miles (millions)	Percent of Total
Air	31,243,100,000	43.6	25,500,000,000	40.3
Rail	25,889,000,000	35.8	23,200,000,000	36.7
Bus	14,886,000,000	20.6	14,500,000,000	33
Total	72,018,100,000	100.0	63,200,000,000	100.0

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Trunkline Load Factors

AIRLINE	1957	1958
American	64.9	66.1
Braniff	58.7	59.1
Capital	58.9	57.9
Continental	53.9	51.2
Delta	59.3	58.5
Eastern	59.5	53.05*
National	59.7	54.2*
Northeast	47.4	47.4
Northwest	57.2	55.4
TWA	62.8	64.5
United	60	64.6
Western	64.5	54.5

*Estimated

be depressed although there are flurries of bids from time to time that lend encouragement to traders in the plane market. American Airlines last year sold 25 DC-7s to General Aircraft and Leasing Corp. at a price of approximately $900,000 each. However, current demands for large piston-engine aircraft are not sufficient to indicate a quick upturn in prices is in the offing.

Last year, two carriers—National and Delta—were forced to cut back on their original orders for DC-8s and many observers feel this is not the last of cutbacks or cancellations. Solution may lie in the leasing of equipment including engines or the farming out of maintenance and overhaul work.

American Airlines has leased all its turbine-engine equipment from manufacturers or from lease agencies representing the manufacturer. National solved its immediate jet problem through a lease agreement with Pan American which permits both carriers to utilize PanAm's Boeings on their respective routes. A further expansion of such programs can be expected late this year or in early 1960.

Most carriers are not anticipating any major operational problems as the transition from piston-engine equipment to turbine-powered aircraft increases in scope. Domestically, both American and National held to an impressive operational performance factor during the early stages of Boeing 707-120 schedules. In the first two months of its turbojet service, National experienced two engine failures with the Boeing, only one of which called for an off-station engine change.

In addition, the two carriers reported few airways traffic problems, primarily because of the limited traffic volume in high-altitude airways. National, which operates under complete radar coverage between Florida and New York, told AVIATION WEEK that it has encountered no conflicting traffic enroute and that the aircraft enters into holding stacks without suffering too severe an economic penalty.

U.S. Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIERS, DOMESTIC & INTERNATIONAL SERVICE

	Douglas				Viscount		Lockheed				Martin		Boeing		Convair			Fairchild	Curtiss	Grumman	Totals
OPERATOR	DC-7*	DC-6†	DC-4	DC-3	V810	V745	188	1649	‡1049	749 049	404	202	707	377	440	340	240	†-27	§C46	G-121	
Allegheny				15								8									23
American	58	83															54				196
Bonanza				10																	10
Braniff	6	10		20											8	25			2		68
Capital			12	19	1	58				11											101
Caribbean-Atlantic				4																	4
Central				13																	13
Continental	5	3		13	14											9					44
Delta	21	7		12						4						32			5		77
Eastern	48	9	1						38	23	58				20						197
Frontier				17																	17
Lake Central				10																	10
Mackey			2	2																	4
Mohawk				8													11				19
National	4	12							7						6	12					*45
North Central				30																	30
Northeast		10		11		7											5				33
Northwest	17	21	12	4										9							63
Ozark				24																	24
Pacific				11								8									19
Panagra	5	5	2																		12
PAWA-AD	17	19	9										6	7							58
PAWA-LAD	7	56	10	2																	75
PAWA-PAD	9		3											16							28
Piedmont				21														5			26
Resort			9																		9
Southern				16																	16
Trans-Texas				20																	20
Trans World			6					39	44	71	37	10									197
United	56	91		1												54					201
West Coast				14														5			19
Western		24		2													6				32
CARGO LINES																					
Aaxico																			24		24
Aerovias Sud Americana			1																2		3
Flying Tiger		2	6						14										2		24
Riddle			2																38		40
Seaboard & Western			3						8										1		12
Slick		3	1																3		7
TERRITORIAL AND ALASKA LINES																					
Alaska Airlines		3	2	1															3		9
Alaska Coastal																				8	8
Cordova				2															1		3
Ellis																				9	9
Hawaiian		1		8												5					14
Northern Consolidated				4																	4
Pacific Northern			2	4						3											9
Reeve Aleutian			1	2															1	1	5
Trans Pacific				8																	8
Wein Alaska				2															5		7
Total: All Domestic and International Aircraft	252	359	84	330	15	65		39	111	112	95	26	6	32	31	133	76	10	87	18	1,875

* DC-7, -7B, -7C † DC-6, 6A, 6B ‡ L 1049, 1049CD, 1049G, 1049H • Includes 7 L18' § C46 & CW20T

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U.S. Flag Lines Feel Competitive Pinch

By Glenn Garrison

New York—Increased foreign competition, slowed traffic growth, and labor troubles helped make 1958 a problem year for most U.S. flag carriers as they struggled to handle the transition problems and financial load of expensive jet fleets now rolling off production lines.

Pan American World Airways kicked off the U.S. jet age last fall with transatlantic Boeing 707-120 schedules, but heavy impact of jets on the international market won't be felt until they are delivered in quantity sometime next year. Meanwhile, U.S. operators faced a snarl of international controversy over jet surcharges and bilateral agreements as they prepared for full-scale jet services.

Foreign-flag carriers with expanded piston and turboprop fleets made the most of the interim last year and cut into the U.S. share of the total traffic. The U.S. carriers registered slight gains for the most part in 1958 but in some cases suffered decreased traffic totals. For various economic and political reasons, services to some geographical areas were particularly hard hit and even where business was still booming, as on the North Atlantic, the U.S. share was smaller.

Pan American, biggest U.S. flag operator, gained only 9,720 passengers last year in its world-wide services—an increase of .03% to 2,892,894. Its Atlantic operation was responsible for this small gain, since Pan American's Latin Division and Pacific-Alaska Division traffic were well under 1957 totals.

Latin Price War

Trans World Airlines, hit by a mechanics' strike last fall, carried 273,870 scheduled passengers on its international routes, a gain of .9% over the previous year. TWA, however, carried 44,933 charter passengers, mostly under Military Air Transport Service Contract, during 1958, for a total scheduled and charter increase of 13.7%. Panagra's traffic between the U.S. and South America dropped from 139,409 passengers to 128,776. The airline went to the Civil Aeronautics Board last fall with a request for subsidy, blaming its losses on cut-rate foreign competition and expressing the fear of an all-out price war in the South American air market.

Delta Air Lines' international traffic fell from 70,062 to 57,829 passengers. President C. E. Woolman listed the economic recession and political unrest in the Caribbean as factors in the 1958 results. United Air Lines carried 100,160 passengers in its territorial operation to Hawaii, a drop of 1.8%.

American Airlines carried 127,000 passengers between the U. S. and Mexico, down from 138,000 in 1957. American last January began flying daily non-stops between Chicago and Mexico under new authority resulting from the Mexican-U. S. agreements of 1957. Nonstop character of the flights resulted in an increase in passenger miles for the year from 100,303,000 to 115,302,000. A pilots' strike and increased foreign and U. S. competition to Mexico were factors in the passenger drop.

Other Gains

Braniff Airways' South American operations showed a 6.2% gain in 1958 for a total of 46,548 passengers. National Airlines carried 51,433 passengers on its routes to Cuba from Miami, New York and Tampa, up from 40,168 in 1957.

Total travel market between the U. S. and foreign countries increased last year, but at a slowing pace. Air passengers totaled 3,402,333 during the year ended June 30, 1958, an increase of 11% compared to a 15% increase during the previous year (most Canadian traffic is excluded from these figures). U. S. scheduled and nonscheduled flag lines' share of the total was 60% during the year ended June 30, 1958. This was a drop of 2%.

Foreign flag carriers increased their total of passengers into the U. S. by 13% and of passengers departing the U. S. by 23%. Respective U. S. air carrier increases were 5% and 10%.

Airlines fared extremely well, however, compared to sea carriers during the year ended June 30, 1958. Arrivals in the U. S. from foreign countries by sea dropped 7% to 634,644 passengers. Departures increased by only about 5,000 passengers for a total of 584,906. Air traffic led sea traffic for the period by 2,182,783 passengers.

Pan American's appearance last year as the first U. S. jet operator on the international scene emphasized a number of political, economic and operational problems the U. S. flag carriers face. In one of the bitter battles over traffic right agreements between this country and others, inauguration of Pan Am's jet service to Paris was threatened by France's denunciation of its bilateral pact with the U. S. It appeared uncertain almost up until the Oct. 26 inaugural date whether France would let the Pan American jet come into Paris. France's requests for a polar route and broader service rights in the U. S. are still under negotiation. They are typical of the controversial problems which exist in this area as foreign carriers seek to expand their U. S. markets and U. S. carriers battle against the inroads of foreign competition.

Another battle with Pan American in the thick of the fray broke into the open last fall when International Air Transport Assn. members deadlocked on the question of jet fares. At their traffic conference in Cannes, the airlines failed to agree on this hotly fought issue of whether a surcharge shall be applied to all turbojet fares. Pan American, backed by British Overseas Airways Corp. among others, resisted imposition of a surcharge and the conference ended without a solution. It reconvened last month and was striving hard for a compromise agreement by March 31, date the current fares expire. Unless the IATA members agree, an open-rate crisis could develop on the North Atlantic this year.

Noise Problem

From the operational standpoint, the first big hurdle Pan American had to clear with its jets was the noise barrier thrown up at Idlewild by the Port of New York Authority. An 11th-hour approval by the Port Authority allowed the airline to bring in the 707-120 under rigid operating restrictions which were gradually reduced by the start of service. The remaining anti-noise restrictions severely handicapped the jet in its first scheduled operations by limiting runway use and hence takeoff weight, resulting in a service that was rarely nonstop. BOAC's smaller de Havilland Comet 4 jet transport was also cleared for Idlewild operation and New York-London service began Oct. 4. The Comet service was not hampered by the restrictions. The situation has been improved for the Boeing by runway extensions at the airport.

For similar anti-noise reasons, Pan American had to shift its Paris jet operation from Orly to Le Bourget. Another problem arose at Rome, where the airline's initial Paris-Rome continuing flights were made with piston aircraft instead of jets because the Italian government found difficulties in the proposed jet operation at Rome's airport. Italy was accused at the time of taking its stand because of the surcharge issue, in which Alitalia is a leading proponent of a higher jet fare. The ban was lifted, however, and Pan American is now flying its jets to Rome.

The airline's contract with its pilots

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expired last year as jet services were getting under way and all jet flights for the first few months were flown by supervisory pilots. This limited the expansion possibilities, but Pan American and the pilots signed a new agreement last month, adding a third pilot to flights not already carrying a pilot-qualified navigator. Top pilot pay under the new contract went up to $33,000.

Pan American and the other transatlantic airlines carried a total of 1,193,000 scheduled passengers across the North Atlantic last year, a gain of 23% over 1957. This happy exception to the general picture was blurred somewhat from the U. S. flag point of view by the fact that Pan American's traffic increase was only 8% and TWA's was only 4.5%, the rest of the increase going to their foreign flag competitors. Pan American had increased its capacity on the route only 12%, however, compared with an over-all seats available increase of 33%. Big factor in the transatlantic results was the new economy class fare, which went into effect last April and accounted for more than half the 1958 passenger total.

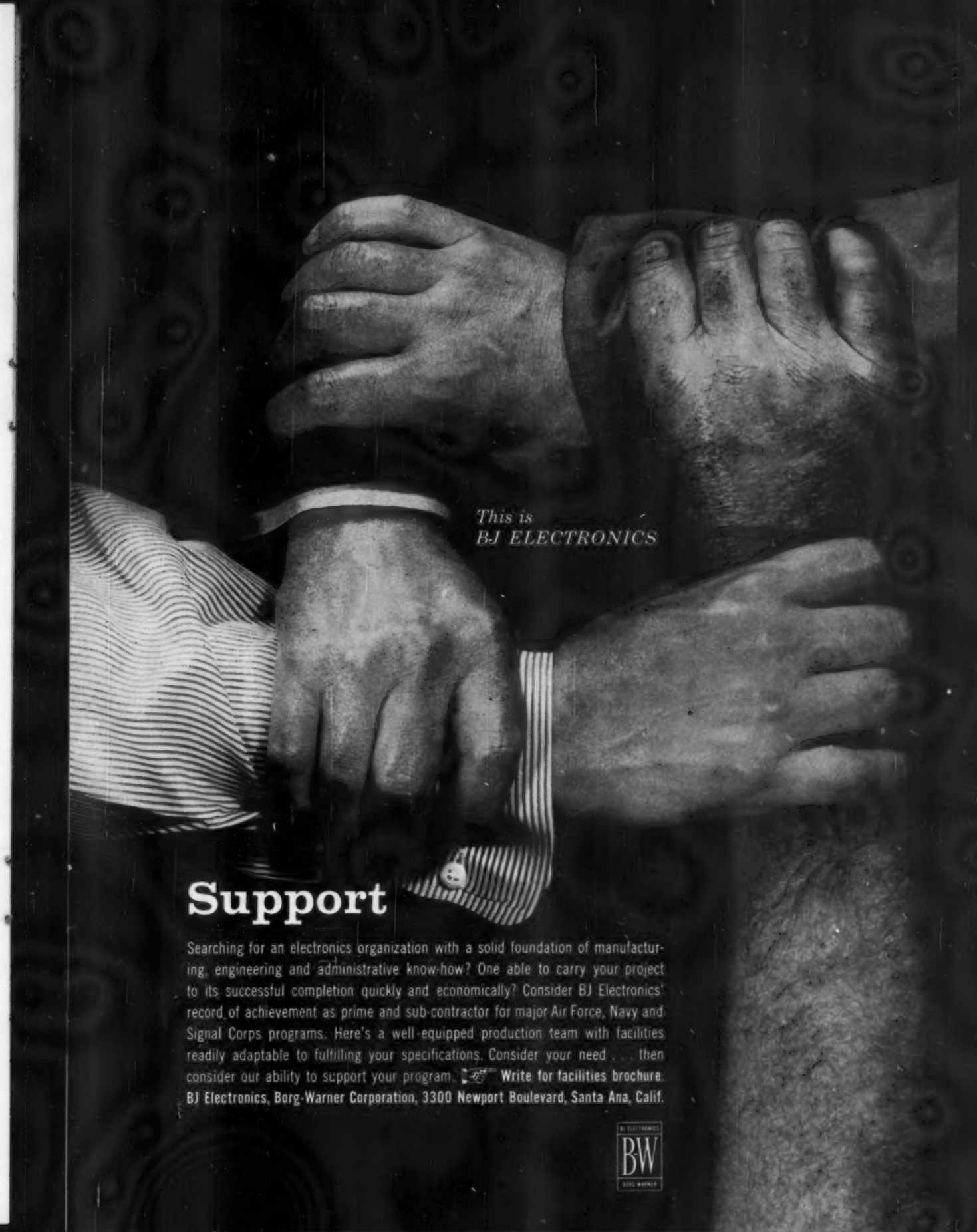
The economy fare touched off the transatlantic battle of the sandwich. The new class, supposedly limited by IATA to minimal passenger comforts and comestibles, brought fierce competition in so-called sandwich offerings which led to at least one $20,000 fine by IATA against a foreign carrier. The U. S. flag carriers' sandwiches were unambiguous and caused no trouble. If nothing else, the sandwich war produced a number of tongue-in-cheek newspaper features and thereby drew much attention to the new fare.

Pan American and TWA operated their polar route services between the West Coast and Europe for the first full year in 1958, with Douglas DC-7Cs and Lockheed 1649A Constellations, respectively. Pan American's passenger total was 19,818, and TWA carried 9,100 passengers on the route.

North America, including its neighboring island areas, continued last year to be the major source of air travel between the U.S. and foreign points. Total for the year ended June 30, 1958, was 801,061 passengers departing the U.S. for North American points, with Cuba accounting for 279,191 of the total, the British West Indies 227,980, and Bermuda third with 93,181.

Second area in volume in such travel was Europe, with 567,502 passengers arriving from the U. S. by air. Of these 155,881 air passengers departed the U.S. for the United Kingdom; 98,751 departed for Germany, and 85,878 departed for France.

IDLE TWA Constellations line the ramp at Idlewild during last year's strike.



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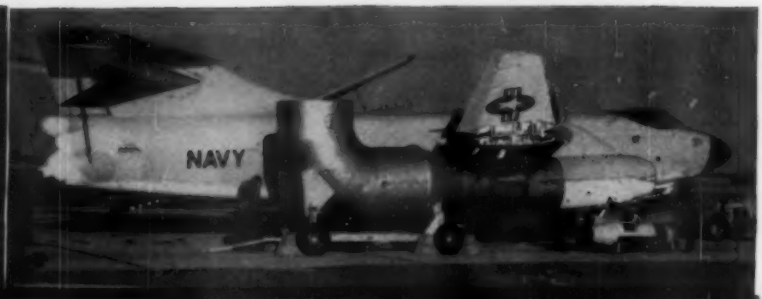

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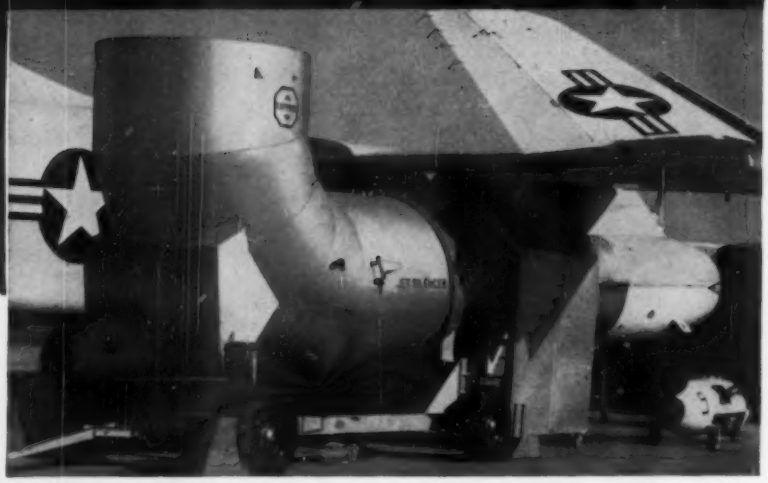

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WEST COAST Airlines' Fairchild F-27 turbine transport taxis on ramp at Seattle.

Local Service Carriers Cite Progress

By Robert H. Cook

Washington—Local service carriers are facing 1959 with renewed vigor and optimism as a result of progress last year which saw significant gains in all phases of their operations and legislative action removing many roadblocks to future growth.

However, any hope of a subsidy free status for this class of carrier is not expected to be realized before the passage of a full decade (AW Dec. 22, p. 39) as a result of new equipment programs and route expansions, both of which began to materialize in 1958. An estimated 79% of the total industry subsidy is currently paid to the 13 local service airlines which will collect $48.9 million for Fiscal 1960. Legislation being sought this year for further flight re-equipment aid could appreciably increase this figure, according to industry spokesmen.

Nonetheless, last year's advancement constitutes a solid and practical base, local service operators say, which will allow them to attain, step by step, an eventual independent status. Both Congress and the Civil Aeronautics Board have pointed out that while new route awards and heavy flight re-equipment programs will undoubtedly increase subsidy bills, they are confident this combination will increase the carriers' earning power sufficiently to achieve a goal of a subsidy free operation.

Preliminary estimates submitted by the carriers for 1958 indicate the fol-

PASSENGER and baggage loading procedures followed by West Coast for its F-27 service.

U.S. Local Service Airlines

SELECTED OPERATING STATISTICS YEAR 1958

	Rev. Plane Miles (000)	Rev. Passenger Miles (000)	Passengers		Average Passenger Load	Passenger Load Factor (%)	Total Rev. Ton Miles (000)	Ton Mile Util. (%)	Avg. Rev. Load (Tons)	Performance Factor (%)	Revenue Hours	Oil-On Speed	No. of Departures	Avg. Length of Hop (Miles)	Daily Aircraft Utilization
			Originating	Enplaned											
Allegheny	6,343	84,196	475,832	488,615	13.3	50.9	8,639	47.6	1.36	93.2	43,852	144.6	77,115	82.3	5:19
Bonanza	4,047	42,336	182,086	185,024	10.5	49.8	4,238	43.6	1.05	99.6	26,751	151.3	32,257	125.5	7:20
Central	3,732	26,872	138,090	143,133	7.2	34.3	2,780	31.0	0.75	97.7	25,286	147.6	45,430	82.1	5:16
Frontier	6,181	62,704	331,935	360,582	10.1	48.3	7,037	47.4	1.14	98.9	41,293	149.7	62,560	98.8	7:14
Lake Central	3,064	29,289	182,589	186,617	9.6	45.5	3,025	41.1	0.99	98.3	21,887	140.0	43,920	69.8	6:00
Mohawk	5,040	87,291	453,765	495,140	17.3	58.0	8,771	54.5	1.74	94.7	32,900	153.2	52,437	96.1	4:37
North Central	11,263	125,931	746,496	777,140	11.1	53.2	12,792	47.3	1.14	98.2	79,184	142.2	139,835	80.5	7:32
Ozark	6,351	72,578	423,785	431,268	11.4	54.4	7,465	49.0	1.18	98.5	45,003	141.1	73,715	86.2	5:56
Pacific	5,384	83,466	375,718	394,771	15.5	54.1	8,246	49.5	1.53	98.3	33,889	158.9	58,222	92.5	4:58
Piedmont	7,807	86,425	410,891	448,005	11.1	52.0	8,755	46.2	1.12	98.1	53,182	146.8	92,780	84.1	6:49
Southern	4,076	41,818	222,956	226,230	10.3	48.9	4,333	44.3	1.06	98.1	27,854	146.3	51,896	78.5	5:27
Trans-Texas	6,163	54,934	240,439	252,931	9.0	42.4	5,875	39.7	0.95	97.7	39,109	157.6	75,949	81.1	5:21
West Coast	4,104	46,520	248,436	294,200	11.4	50.7	4,634	44.8	1.13	96.3	29,630	138.5	57,658	71.2	5:19
Total-Average	73,555	844,372	4,233,038	4,583,656	11.5	50.5	86,590	46.1	1.18	97.5	499,820	147.2	863,774	85.2	5:55

lowing results:

• **Operating revenue** increased from $82,139,942 in 1957 to $94,307,767 last year for a 14.8% gain.

• **Operating expenses** of $93,093,856 were 12.3% above those of $82,900,215 for 1957.

• **Operating income** of $1,213,911 was realized last year as compared with a loss of $760,273 for the previous year.

• **Total mail pay** climbed from $30,861,311 in 1957 to $33,521,316 for last year.

• **Revenue plane miles** of 73,555,000 were 7% above the 68,402,000 recorded for the previous year.

• **Passenger load factor** average advanced from 49.9% for 1957 to 50.5% last year, for a gain of 0.6%.

Significant developments which accounted for local service growth last year and will provide for further expansion this year are:

• **Guaranteed Loan Bill** authorizing the government to guarantee 90% of loans up to $5 million for the purchase of new flight equipment. By the end of 1958 a total of $13,805,500 was approved for guarantee by the Civil Aeronautics Board for Bonanza, Piedmont and Pacific airlines, all of which purchased the new Fairchild F-27 turboprop as a replacement for DC-3s. This year North Central Airlines obtained approval of a $2,340,000 loan for the purchase of five Convair 340s.

Passage of the bill is considered one of the most important milestones in the local service industry. Its supporters say it will enable the carriers to attract the necessary financial backing to begin a modernization of badly outmoded fleets. Pressing need of the locals for an almost complete revamping of their fleets, along with the relatively high price of such aircraft as the F-27, which sells for $600,000, plus the apparent willingness of some lending institutions to make loans backed by the bill, have influenced the carriers to enter new legislation asking that Congress extend the loan guarantee to a maximum of $10 million.

• **Passage of capital gains** legislation last April to permit carriers to retain gains realized from the sale of obsolete flight equipment. This includes a proviso that the money be actually reinvested in new equipment or set aside in a special fund for such a future purpose. Retention of this gain worked hand in hand with the loan guarantee since any sum formerly realized from such a sale was deducted from the carrier's set subsidy pay.

This practice, in the past, virtually wiped out the airlines' greatest source of capital. Since lenders qualify their loans on a basis of both net worth and operating income combined, local service airlines found it difficult to obtain financing.

• **Expansion of route systems** and lifting of restrictions in the Seven States Area Case alone added 33% to the nation's local service mileage, split three ways among Frontier, North Central and Ozark airlines. Fifty-six new cities reached in the 8,000 mi. extension

Local Service Airlines

Preliminary or Estimated Operating Financial Results Year 1958

	Passenger Revenue	Total Non-mail Revenue	Total Mail Pay	Total Operating Revenue	Total Operating Expense	Operating Profit
Allegheny	$5,085,759	$6,155,203	$3,590,299	$9,745,502	$9,364,660	$380,842
Bonanza	2,690,651	2,847,527	1,660,001	4,507,528	4,602,662	(95,134)
Central	1,824,867	1,984,024	2,886,787	4,870,811	4,693,989	176,822
Frontier	4,007,232	4,476,136	2,582,456	7,058,592	7,551,123	(492,531)
Lake Central	2,050,704	2,358,831	1,846,658	4,005,489	3,876,401	129,088
Mohawk	6,408,460	6,842,588	2,804,484	9,647,064	8,943,850	703,214
North Central	8,609,637	9,350,437	3,567,690	12,918,127	12,926,801	(8,674)
Ozark	5,027,710	5,434,916	2,829,765	8,264,681	7,987,959	276,722
Pacific	4,525,299	4,947,227	1,881,080	6,828,307	7,168,141	(339,834)
Piedmont	6,107,575	6,638,991	2,586,816	9,225,807	8,875,221	350,586
Southern	2,799,425	2,950,107	2,473,588	5,423,695	5,094,253	329,443
Trans-Texas	3,565,829	3,952,779	3,076,553	7,029,332	6,586,369	442,963
West Coast	2,908,700	3,048,093	1,735,139	4,783,232	5,422,428	(639,196)
Totals	$86,412,646	$50,786,451	$33,521,316	$94,307,767	$93,093,856	$1,213,911

Source: Ray & Ray, Wash., D. C.

were added to the local service system. Of this total, 26 cities will receive their first airline service and 45 will receive local service exclusively. Involved also were 24 trunkline suspensions with 19 cities transferred entirely from trunk to local service.

Civil Aeronautics Board decisions are expected to swell this total to a new high this year in the remaining local service markets in the Great Lakes Local Service Case; Northeastern States Area Case; Pacific Northwest Area Case; Montana Local Service Case; Southeastern Local Service Case and the Piedmont Local Service Case.

• **Rate of return** increase from 8% to 9.5% on investment, plus later CAB action redesigning the temporary mail rate formula to include interest on long term debt in addition to the break-even need provided some relief for the local carriers. Pending is a final Board decision in the Local Service Rate of Return Case in which participants requested rates as high as 12%.

Association of Local and Territorial Airlines, under the leadership of Joseph P. Adams, a former CAB member, has long urged a revision of CAB's rate making procedures and their efforts promised reward last year when Board members unveiled a new basic formula for subsidy payments which could have the end result of eliminating time consuming temporary and final mail rate hearings.

Under the proposed plan (AW Nov. 10, p. 45) local service carriers would be paid a monthly subsidy calculated on a predetermined portion of a standard cost of operation per plane mile, including a reasonable profit, for a set number of frequencies over each route segment. The percentage of cost paid would decrease as the number of trips increased with the government and carrier sharing annually in all profits above a given profit level governed by a predetermined and fixed ratio.

While events of the past year have been favorable to local service growth there yet remain many problems which ALTA feels must be resolved such as:

• **Consolidated engine overhaul** facilities which will be particularly needed for the growing local service trend towards the use of turbine power plants.

• **Joint purchasing** and use of facilities by groups of local service operators to lower over-all operating costs.

• **Adoption by CAB** of a more lenient mileage disallowance policy.

• **Present 10 year** depreciation period, which the carriers feel should be changed to only 7 years because of present loan retirement problems when depreciation periods and longer.

• **New system** for distributing interline passenger revenues, which would favor local air carriers more than the present.

Local Service Airlines

Comparison of Financial Data Years 1957 and 1958

	Amount		Increase 58/57	
	1957	1958[1]	Amount	Per cent
Passenger Revenue	$47,464,945	$56,412,846	$8,947,901	18.9%
Other Non-Mail Revenue	3,813,686	4,373,605	559,919	14.7
Total Non-Mail Revenue	51,278,631	60,786,451	9,507,820	18.5
Total Mail Pay	30,861,311	33,521,316	2,660,005	8.6
Total Operating Revenue	82,139,942	94,307,767	12,167,825	14.8
Total Operating Expense	82,900,215	93,093,856	10,193,641	12.3
Operating Profit	(760,273)	1,213,911	1,974,184	....
Break-Even Need	31,621,584	32,307,405	685,821	2.2

Source: Ray & Ray Wash., D. C.
[1] Preliminary or Estimated Data for 1958

REVENUES AND EXPENSES YEAR ENDING SEPT. 30, 1958

	Operating Revenues				Total Operating Expense	Operating Profit (or Loss)
	Passenger	Total Non-mail	Mail and Subsidy	Total		
Allegheny	5,496,264	5,807,091	4,242,243	10,049,334	9,205,733	843,601
Bonanza	2,509,716	2,668,141	1,671,824	4,339,965	4,379,932	(39,967)
Central	1,697,877	1,845,776	2,751,209	4,596,985	4,549,546	47,439
Frontier	3,855,286	4,340,398	2,602,434	6,942,792	7,181,464	(238,672)
Lake Central	1,837,995	1,933,601	1,926,368	3,859,969	3,836,087	23,882
Mohawk	5,893,100	6,375,721	2,655,622	9,031,343	9,078,141	(46,798)
North Central	8,224,309	8,829,440	4,095,167	12,924,607	12,492,402	432,205
Ozark	4,682,066	5,004,936	2,838,252	7,843,188	7,825,464	17,724
Pacific	4,327,719	4,649,639	1,884,935	6,534,574	6,972,860	(438,286)
Piedmont	5,736,122	6,224,314	2,582,506	8,806,820	8,613,588	193,232
Southern	2,504,162	2,609,563	2,373,080	4,982,643	4,927,539	55,104
Trans-Texas	3,363,023	3,730,763	3,070,897	6,801,660	6,617,864	183,996
West Coast	2,753,265	2,884,015	1,747,367	4,631,382	4,951,304	(320,022)
Total	52,880,904	56,903,358	34,441,804	91,345,162	90,631,724	713,438

COMPARISON OF OPERATING STATISTICS

	1957	1958	Increase 58/57	
			Amount	Per cent
Revenue Plane Miles (000)	68,458	73,555	5,097	7.4
Revenue Passenger Miles (000)	766,214	844,372	78,158	10.2
Originating Passengers	4,013,861	4,333,038	319,177	8.0
Enplaned Passengers	4,235,921	4,583,656	347,735	8.2
U. S. Mail Ton Miles	1,520,182	1,720,595	200,413	13.2
Express and Freight Ton Miles	3,725,584	4,055,695	330,111	8.9
Average Passenger Load (Persons)	11.2	11.5	0.3	2.7
Passenger Load Factor % (21-36 Seats)	49.9	50.5	0.6	....
Total Revenue Ton Miles (000)	78,514	86,590	8,076	10.3
Ton Mile Utilization (%)	45.3	46.1	0.8	....
Average Revenue Load (Tons)	1.15	1.18	0.03	2.6
Performance Factor (%)	96.7	97.5	0.8	....
Revenue Hours	472,605	499,820	27,215	5.8
Off-on Speed (m.p.h.)	144.9	147.2	2.3	1.6
Number of Departures	828,030	863,774	35,744	4.3
Average Length of Hop (Miles)	82.7	85.2	2.5	3.0
Daily Aircraft Utilization	5:58	5:55	(0:03)	(0.8)
Average Length of Journey:				
Originating Psgr.	191	195	4	2.1
Enplaned Psgr.	181	184	3	1.7
As of Fourth Quarter:				
Average No. of Aircraft	226	247	21	9.3
Number of Employes	8,552	9,131	579	6.8
No. of Stations Operated	414	426	12	2.9
Route Miles Operated (Undup)	33,996	35,885	1,889	5.6
Daily Route Mile Turnover	5.61	5.70	0.09	1.6

This Kidde ground service cart does everything from inflating a tire to starting a jet!

Weight: Approx. 150 lbs.
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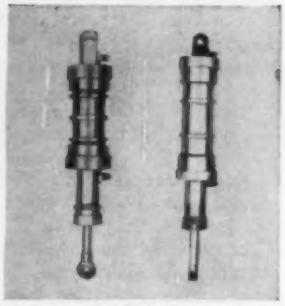

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Recession Turns Shippers to Air Cargo

Washington—Shipper concentration on air cargo as a practical and economical means of inventory control during last year's recession pumped new life into this phase of aviation which showed a 12.2% gain in air cargo revenue ton miles in 1958 by domestic, local service and all-cargo carriers.

Encouraged by last year's boom record of 637,611,000 revenue ton miles for mail, express and freight informed observers are predicting a gain of 23% this year as a result of new emphasis by major trunk carriers on air cargo, plus the introduction of more high cargo capacity jet aircraft. In addition, many feel the year-end picture may affect the final decision of the Civil Aeronautics Board in the current Domestic Cargo-Mail Service Case and result in permanent certification for all cargo carriers which have operated on an experimental basis under temporary authority for the past 10 years.

Combined industry revenue ton miles for mail were up 9% last year to 109,597,000 miles; express miles increased by 7% to 49,181 and air freight climbed to 479,033,000 revenue ton miles to reflect a 13.7% gain over the previous year. In particular, gains registered by the all cargo carriers, such as AAXICO, Aerovias, Flying Tigers, Riddle, Seaboard and Slick, came as a surprise since earlier estimates, based on nine months actual and three months estimated figures and reflecting the withdrawal of Slick from active service in the beginning of last year, indicated this group would suffer losses of 40.2% in mail volume, 56.2% in express and 31% in freight. This would be a total decline in year total revenue ton miles carried of 11.3% or 298.7 million ton miles.

Current figures show that these carriers handled 234,894,000 ton miles of air freight in 1958, 1,112,000 ton miles of express and 2,723,000 ton miles of mail for a total of 238,729,000 miles and a gain of 18% over 1957.

Partial clue to the air cargo performance lies in adoption of an austerity type buying pattern by business groups cutting back on inventories during the recession. Quick deliveries offered by air freight on small shipments were reported to reward users with savings at a ratio of $2 for each $1 spent for air shipments because of elimination of inventory financing charges and manpower reductions.

Military Rise

Second step in recognizing the importance of air cargo operations came with the congressional investigation of the Military Air Transport Service last year, resulting in a Department of Defense decision to spend $80 million on commercial air transportation this year, or more than $23 million above the sum alloted by the military in 1958. Tail end of this increased expenditure program was dramatically demonstrated in year end revenue figures from the Joint Airline Military Traffic Offices which reported a 600% gain in military air cargo revenues for 1958. Last year JAMTO cargo revenues amounted to $1,959,406 as compared to only $259,523 for the previous year.

Above all trunkline cargo men feel that air cargo has been promoted from its former status of a stepchild in combination carrier airlines. While many of the major trunks operate a few all cargo or combination type aircraft, American Airlines has taken one of the major steps to lead the way to further air cargo progress within the domestic industry with an announcement that it will convert 10 of its DC-7B passenger planes to cargo aircraft at a total conversion cost of $4.2 million (AW Feb. 9, p. 47). Now operating 10 DC-6As as air freighters, American's addition of the converted aircraft will double the airline's cargo capacity.

Competitive impact of American's high speed transcontinental fleet can be expected to spur other major trunks to increase the size and service of their present cargo operations this year, observers say.

Among the all-cargo carriers, Flying Tigers underwent a modernization of its fleet by replacing its C-46 and C-54 aircraft with 13 Lockheed Constellation 1049Hs. Savings realized on operation of the new planes, plus the capture of much of Slick's abandoned airfreight business, accounted for a major portion of an estimated 22 million additional revenue ton miles the airline realized last year over 1957.

Turbine Potential

While Flying Tiger spokesmen say their Constellations have proved an operational saving, future expansion may depend on yet lower operational costs which could be afforded with turboprop equipment such as a civilian version of Lockheed's C-130 Hercules. The manufacturer claims this aircraft, designated the C-130B, can haul a 47,000 lb. payload at 5.9 cents per revenue ton mile as compared to the industry search for a freighter operating at 10 cents per revenue ton mile.

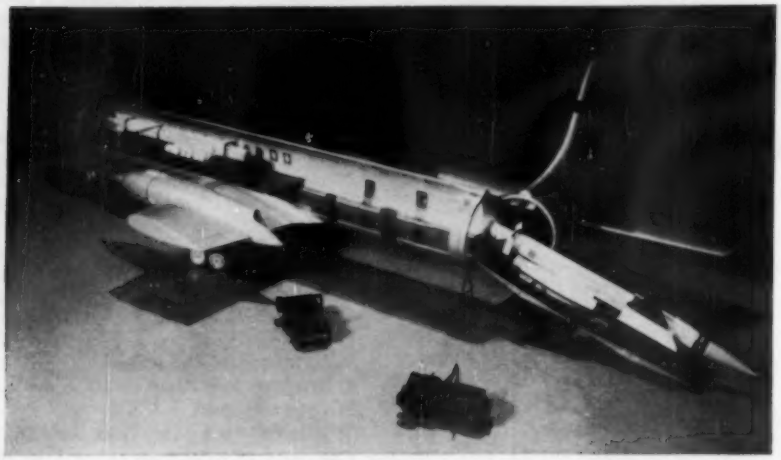
While both Flying Tiger and American have expressed an interest in the

AIR CARGO IN SCHEDULED SERVICE 1957-1958

	THOUSANDS OF REVENUE TON MILES					
	Mail		Express		Freight	
	1958	1957	1958	1957	1958	1957
DOMESTIC TRUNK LINES						
American	20,249	19,884	9,608	8,999	91,178	82,408
United	31,132	28,465	11,025	9,552	66,984	56,637
TWA	13,677	12,478	7,065	7,345	24,018	25,512
Eastern[1]	11,240	11,203	5,336	5,297	13,803	15,636
Braniff	3,914	3,115	2,056	1,419	6,705	5,077
Capitol	5,703	5,168	2,809	2,373	3,772	4,517
Continental	1,207	1,083	543	458	1,969	1,561
Delta	5,190	4,248	3,270	2,882	12,801	9,002
National[1]	3,574	3,228	647	611	5,959	5,193
Northeast	1,108	517	372	249	1,175	645
Northwest	5,829	4,727	2,828	2,472	11,125	9,427
Western	2,130	3,084	708	1,095	2,397	2,890
Total Trunk	104,953	97,200	46,267	42,752	241,886	218,505
LOCAL SERVICE LINES	1,721	1,520	1,802	1,643	2,253	2,083
ALL CARGO						
AAXICO	112	34	209	144	40,365	2,056
Aerovias	.....	.....	.....	.....	8,106	8,849
Flying Tiger	473	449	481	422	104,073	82,986
Riddle	340	511	377	324	58,595	31,554
Seaboard	1,722	.....	.....	.....	19,315	17,939
Slick	76	846	45	719	4,440	49,800
Total Cargo	2,723	1,840	1,112	1,609	234,894	193,184

[1] 12 Months Ending Nov. 30, 1958.

SOME cargo carriers are showing interest in a commercial version of the Lockheed C-130.



MISSILE carrying capability of Canadair CL-44 is demonstrated in this view of model, which has outboard section of wing cut away. Aircraft is powered by four Rolls-Royce Tyne 12 turboprop engines, producing 5,730 eshp. each. Aircraft design incorporates lowered aft fuselage floor to accommodate objects of more than 100 in. in height and weight.

SWING-TAIL cargo version of Convair 600 turbojet transport has been proposed to U.S. Air Force and commercial airlines (AW Feb. 23, p. 41). Tail is swung aside by power provided by the airplane. Convair said 600 should be able to fly New York-Los Angeles round trip run, with 70,000 lb. payload both ways, in 8 hr. 6 min.

C-130, most observers doubt that a civilian version will be purchased until per plane payloads reach a point to justify the aircraft's large capacity and high initial cost.

In the re-equipment spotlight now is the British built Armstrong Whitworth 650 Argosy powered by four Rolls-Royce Dart engines. Riddle airlines has been studying the possibility of an Argosy purchase as a replacement for its fleet of 34 low capacity, high operational cost C-46s. The Argosy is designed to carry a payload of 27,000 lb., as compared to only 13,000 lb. for the piston engine C-46 with a direct operating cost of 10 cents per ton mile.

Speed advantage and cargo capacity of new jets, such as the Boeing 707, Douglas DC-8 and Convair 880, is expected to raise further the industry's revenue ton miles figure and supply a new outlet for highly perishable goods. Pan American, citing cargo figures on its jet service across the Atlantic, reports that during the first 15 days of December, its New York to Paris flight carried an average of 7,819 lb. of cargo per flight. The figure nearly equals the cargo loading formerly handled by a Boeing Stratocruiser and a DC-7 over the same route.

Jet Speed

Speed still remains the big selling point for jet cargo loads. Industry leaders look forward to same day deliveries on a coast to coast basis for perishables. At the same time, this speed advantage has caused some operators to think in terms of higher cargo tariffs or a special surcharge similar to that favored by many airlines for passenger carriage. Most observers doubt that any across-the-board tariff raises will be placed on jet cargo but feel a flat surcharge could be levied as a guarantee on perishable deliveries.

Ground handling time for jet cargo is being closely studied by the industry through such organizations as the Air Cargo Terminal Facilities Committee of the Air Transport Assn. The committee expects to develop a guide for the construction of adequate cargo terminal facilities by the end of this year. In addition to working closely with the American Trucking Assn. to improve service to truck-air shippers, ATA is co-ordinating plans with the U.S. Post Office Department for the more efficient movement of mail.

Most favored idea, at present, for speedier delivery and loading of cargo, lies in a containerization experiment now being carried out by American and studied by United airlines. American hopes to use these cargo boxes on one third of its system, currently is using 200 "Paul Bunyan" boxes and estimates a time saving of at least half an hour per plane loading.

Needs of Airports for Jets Stir Debate

By Ford Eastman

Washington—Greater attention will be focused on airport expansion and modernization projects for the next four years as the nation speeds its efforts to catch up with flight progress.

Commercial jet transports have already reached the American scene even though in limited numbers, but airways and terminal facilities are not yet fully prepared to meet the increasing demands for traffic safety, speed and passenger convenience.

There are about 25 airports in the United States upon which a jet airplane could land or take off with a reasonable load and fly the routes now operated by piston planes under favorable conditions. None, however, is completely adapted for full scale jet operations at maximum efficiency, although considerable progress will have been made by the time airlines have completed their jet fleets.

The Federal Aviation Agency surveys of airport development plans for the calendar years 1959 through 1962 show and over-all requirement of $1,299 million in new construction and improvements. The survey covered 3,000 airports in the United States and territories and plans included land, grading and draining, terminal sites, buildings, control towers, lighting, paving and miscellaneous items. The FAA said the plans represented what airport operators considered desirable but not necessarily what would actually be spent on such plans.

A breakdown of the requirements and the cost of the plans is as follows:

Air commerce airports:

- **Site preparation,** $189,868,000.
- **Land,** $108,177,000.
- **Buildings,** $244,197,000.
- **Lighting,** $37,770,000.
- **Pavement,** $359,285,000.
- **Misc.,** $81,076,000.
- **Total** $1,020,313,000.

General aviation airports:

- **Land,** $79,059,000.
- **Building area development,** $28,405,000.
- **Landing area development,** $171,918,000.
- **Total,** $279,382,000.
- **Grand total,** $1,299,695,000.

The airline industry, in planning for the jet age, found that while nearly all existing airports required alteration to some extent, jet transport service could be started, though at somewhat reduced efficiency.

Basic configuration of the major airports is such that they could be made completely suitable if sufficient time and money were available.

In most instances runways would have to be extended and secondary runways constructed, taxiways widened and bypass areas provided, and high-speed turnoffs from runways constructed.

Terminal facilities, in many cases, were found inadequate to handle the current volume of passengers, let alone the big increase expected in the next few years.

The total of 49 million passengers carried by airlines last year is expected to increase to 66 million next year, 93 million in 1965 and 118 million in 1970. Total movements—arrivals and departures—of all aircraft at airports with Federal Aviation Agency control towers increased from 4 million in 1946 to 16 million in 1957. It is forecast that movements in 1960 will number 22 million, in 1965, 30 million and by 1970, 35 million.

One of the major reasons why airport development has failed to keep pace with the increase in air travel and the evolution of aircraft is the lack of financial support from the federal government level down to the community.

Congress, recognizing the need for a national airport system in 1946 authorized a grant-in-aid program to assist public agencies in airport development. Funds appropriated for this purpose were usually far less than had been requested, cut in varying degrees by the Commerce Department, the Budget Bureau and even Congress. No budget requests were permitted to go to Congress in 1954.

Funds Spent

While the 1946 act authorized a total of $500 million to be appropriated in seven years, only $236.2 million had been made in nine years. As a result Congress in 1955 enacted a four-year airport aid act which specified that $63 million would be made available for this purpose annually.

Programs for establishment of air navigation facilities suffered similarly. In 1955 the budget called for about $3 million and in 1956, $23 million. After the Grand Canyon air tragedy, however, the requests were increased to $75 million in 1957, to $146 million in 1958 and to $175 million in 1959.

Congress, after increasing the airport aid bill to $100 million annually last year, which the White House vetoed, lost little time in reconsidering similar action during the current session. The Senate easily approved a four year bill authorizing $100 million annually. The House considered a similar proposal, but White House reaction to such a measure was uncertain.

The Administration, after expressing the desire to phase out federal participation when present committments are completed, this year suggested the phase out be over a period of four years with total appropriations not to exceed $200 million, half the amount Congress seeks.

Besides the amount of federal participation in airport development, the Administration and Congress differ over how it is to be spent. The Congressional bill, introduced by Sen. Mike Monroney (D.-Okla.), would permit federal aid in the construction of terminal buildings. The Administration bill would not.

The Administration strongly opposes federal aid in the building of airport terminals and flatly states that the aid should be concentrated on the safety facilities of airports, where funding from other than Federal sources is not readily available.

Retention of this clause is more likely to result in a presidential veto of the measure than the increased funds specified.

Elwood R. Quesada, FAA administrator, told Congress the "realistic requirements" for airport development in which the Federal government should participate come to about $500 million, not $1.29 billion.

If terminal buildings and miscellaneous facilities beyond the gate are eliminated, and efforts are concentrated on true safety needs, he said, the figure drops well below the billion dollar mark.

History shows, he added, that even if Congress voted funds to pay for half the stated needs, the majority of local communities would not proceed with major portions of their local airport programs.

Quesada estimated that after deducting about $350 million for terminal buildings, this factor would be about 45%, which leaves $500 million to be raised by local communities with the federal government contributing up to half.

An industry survey of airport development during the next four years shows a total need of $1.1 billion. It is anticipated that $521 million of this

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Airport Requirements

	Air Commerce Airports*	General Aviation Airports*	Total Needs*	Federal Aid	
				Monroney Bill**	Administration Bill**
Ala.	$17,569,000	$4,494,000	$22,063,000	$5,295,804	$1,675,816
Ariz.	17,215,000	5,139,000	22,354,000	5,950,444	1,745,488
Ark.	1,907,000	3,608,000	5,515,000	4,249,272	1,316,689
Calif.	158,997,000	41,997,000	200,994,000	17,315,960	5,508,885
Colo.	26,182,000	4,126,000	30,308,000	6,050,036	1,803,467
Conn.	7,603,000	4,900,000	12,503,000	2,154,956	720,823
Dela.	2,161,000	832,000	2,993,000	411,544	134,325
D. C.	.....	.....	.....	761,720	259,525
Fla.	15,540,000	2,183,000	17,723,000	5,395,092	1,689,461
Ga.	19,825,000	2,756,000	22,581,000	5,968,652	1,888,417
Idaho	4,866,000	1,088,000	5,954,000	4,401,576	1,292,891
Ill.	77,779,000	15,036,000	92,815,000	10,903,788	3,573,470
Ind.	3,756,000	6,595,000	10,351,000	5,400,676	1,750,483
Iowa	4,855,000	4,453,000	9,308,000	5,068,736	1,588,151
Kans.	7,279,000	5,316,000	12,595,000	5,587,668	1,700,461
Ky.	17,657,000	6,128,000	23,785,000	4,643,432	1,482,675
La.	20,459,000	14,670,000	35,129,000	4,817,128	1,519,157
Me.	7,459,000	2,358,000	9,817,000	2,443,196	747,646
Md.	22,406,000	6,830,000	29,236,000	2,781,684	917,788
Mass.	32,166,000	10,320,000	42,486,000	4,859,448	1,633,852
Mich.	22,849,000	3,263,000	26,112,000	10,479,096	3,332,038
Minn.	18,464,000	4,825,000	23,289,000	6,790,508	2,100,596
Miss.	13,445,000	5,963,000	19,408,000	4,281,672	1,339,750
Mo.	19,686,000	6,144,000	25,830,000	6,945,648	2,194,782
Mont.	8,372,000	1,516,000	9,888,000	7,329,572	2,133,058
Nebr.	13,721,000	2,040,000	15,761,000	4,807,080	1,546,885
Nev.	5,975,000	190,000	6,165,000	5,237,980	1,510,960
N. H.	3,094,000	1,957,000	5,051,000	932,368	294,744
N. J.	25,081,000	5,031,000	30,112,000	4,950,556	1,667,390
N. Mex.	12,036,000	2,276,000	14,312,000	6,242,712	1,825,846
N. Y.	94,402,000	12,374,000	106,776,000	16,506,140	5,493,402
N. C.	9,319,000	3,720,000	13,039,000	6,266,568	2,005,435
N. D.	3,380,000	2,086,000	5,466,000	3,837,652	1,132,685
Ohio	26,969,000	8,516,000	35,485,000	9,570,308	3,151,776
Okla.	16,680,000	5,254,000	21,934,000	5,329,256	1,643,084
Ore.	8,535,000	1,124,000	9,659,000	5,903,472	1,771,444
Pa.	66,151,000	14,613,000	80,764,000	12,046,824	3,992,660
R. I.	3,828,000	660,000	4,488,000	805,328	271,513
S. C.	6,355,000	2,789,000	9,144,000	3,437,244	1,094,322
S. D.	5,718,000	1,219,000	6,937,000	4,162,624	1,227,612
Tenn.	12,660,000	6,450,000	19,110,000	5,056,560	1,618,928
Tex.	30,375,000	12,188,000	42,563,000	19,593,920	6,015,527
Utah	6,978,000	1,048,000	8,026,000	4,558,884	1,343,145
Vt.	2,283,000	2,386,000	4,669,000	799,368	248,640
Va.	4,667,000	11,519,000	16,186,000	5,085,828	1,628,703
Wash.	15,724,000	2,371,000	18,095,000	5,497,780	1,698,875
W. Va.	6,911,000	3,950,000	10,861,000	3,009,168	965,810
Wis.	16,630,000	6,502,000	23,132,000	6,294,740	1,981,461
Wyo.	3,996,000	1,448,000	5,444,000	4,780,332	1,386,325
Sub Totals	**$949,965,000**	**$276,251,000**	**$1,226,216,000**	**$285,000,000**	**$97,250,000**
Alaska	$36,444,000	$1,327,000	$37,771,000	$9,000,000	$7,783,134
Hawaii	18,959,000	931,000	19,890,000	5,000,000	2,750,000
P. R.	9,240,000	873,000	10,113,000	4,000,000	1,925,000
V. I.	5,705,000	.....	5,705,000	2,000,000	825,000
Sub Totals	**$70,348,000**	**$3,131,000**	**$73,479,000**	**$20,000,000**	**$13,283 134**
Discretionary Funds	.....	.....	.....	160,000,000	97,250,000
Totals	**$1,020,313,000**	**$279,382,000**	**$1,299,695,000**	**$465,000,000**	**$200,000,000**

*Survey by Federal Aviation Agency
**Computation by Senate Commerce Committee Staff

cost will become available from local sources and $68.5 million from state sources, leaving a deficit of $477 million. This includes terminal area development.

George Dement, Airport Operators Council vice president, told Congress that terminal facilities are a vital part of the over-all airport program and should not be excluded from federal aid.

However, he added, there should be no fear that federal money would be spent on terminals if more urgent requirements were necessary.

Dement said projects for which Federal funds are requested are classified on the basis of (1) safety, (2) efficiency and (3) convenience. Since runways and taxiways are safety items, he said, no money would be spent for terminals at an airport where funds were needed for these items.

The Air Transport Assn. pointed out that despite federal government interest in an adequate national system of airports, state and local governments have always carried and will continue to carry the bulk of the financial load. The government's contribution under the Federal Airport Act has averaged between 15 and 20% of the total investment, ATA said. Although more has been authorized, ATA added, the government as of last year, actually expended only $314.7 million under the Federal Airport Act out of the total investment of an estimated $3 billion.

Federal Aid

One of the reasons for the low percentage is that at larger airports where construction costs run into the many millions of dollars, federal aid is very small in comparison. At smaller airports, the situation is different and the percentage runs higher. Federal funds are needed not only to help pay for the projects, but to provide stability to improvement programs and aid in raising funds locally.

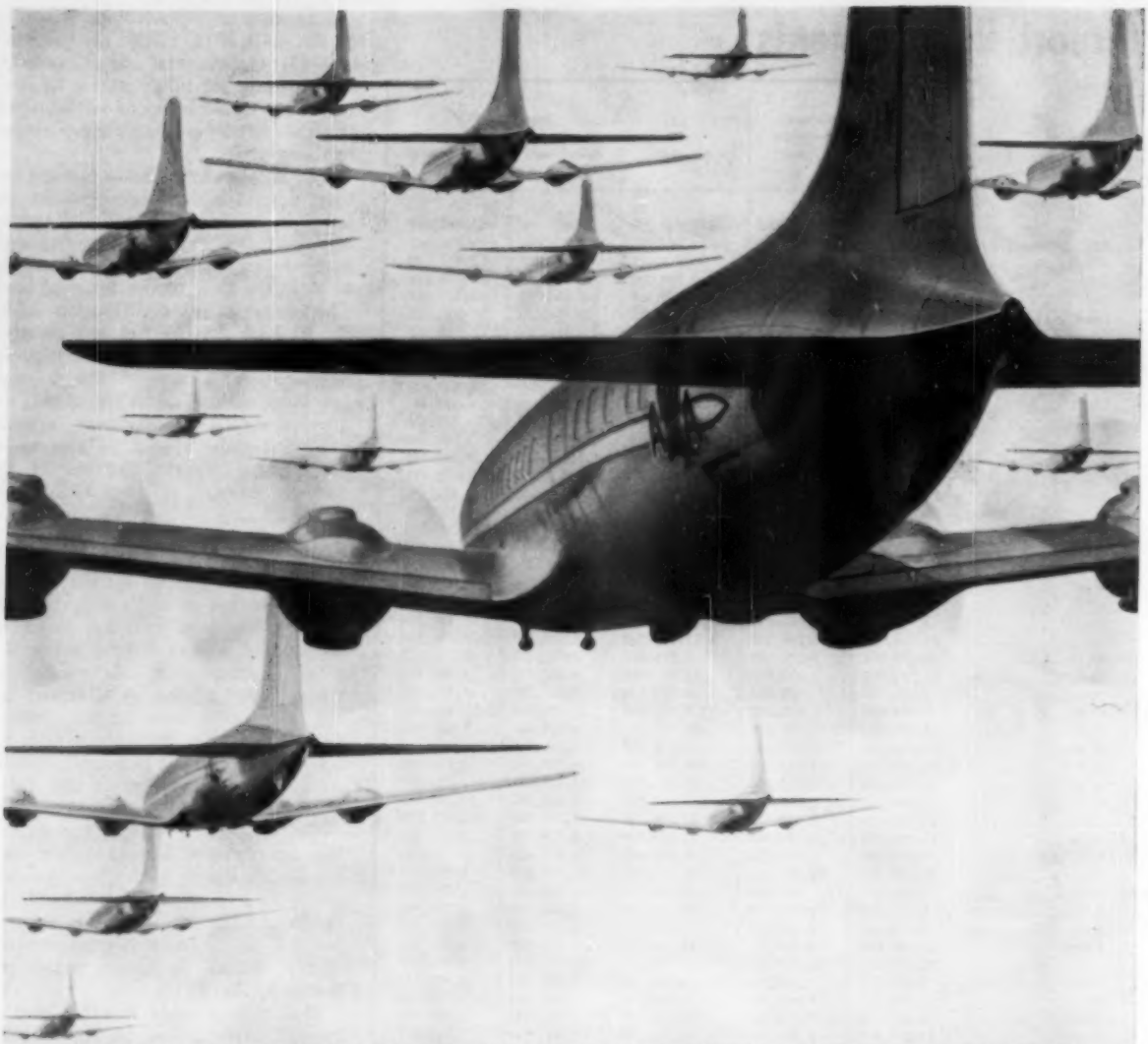
On an over-all basis, Quesada said, the government has expended more funds on airports than those provided under the Federal Aviation Act. He said the total federal contribution amounts to $2.6 billion, including construction under various depression relief programs in the 1930s.

But this is only a small part of federal participation in the development of civil aviation, Quesada added. The government has established and maintained extensive air traffic control facilities and navigational aids without contributions from state and local governments.

1960 Funds

For Fiscal 1960, he said, the government has requested more than $500 million for air safety regulation and for necessary operation, expansion and improvement of the control system. He estimated the total cost would be in excess of $2 billion in the next four years.

Meanwhile, state and local governments, realizing that airports are not adequate to handle full-scale jet operations, have initiated steps to provide financing for expansion programs. Numerous proposals to raise money through appropriations and other ways have already been introduced in state legislatures.



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Aeroflot Shows Big Gain—In Percentages

Moscow—Russia's Aeroflot finished 1958 with traffic gains exceeding its own optimistic goals and with new plans for Soviet air transportation's "shock tempo" development through 1965.

Bolstered by increasing numbers of 50- and 70-seat, twin-jet Tu-104s and Tu-104As, Aeroflot last year flew 56% more passengers than in 1957. Cargo and mail volume—some of it carried by four-turboprop Il-18 Moskvas and An-10 Ukrainas—also reached new peaks.

But the Russians regard 1958's records as only a good starting point for Premier Khrushchev's ambitious Seven-Year Plan for civil aviation growth. This program, which officially began Jan. 1, 1959, seeks to eliminate the last vestiges of backwardness from Aeroflot's operations and to make its services equal to any in the western world.

Turboprop Lag

The Soviet carrier failed to achieve only one major objective during 1958: it was unable to meet deadlines for placing turboprop aircraft in regular passenger operation. This lag is to be remedied in 1959, when, instead of starting Il-18 passenger flights with a few planes, dozens of route-tested turboprops manned by experienced crews will be available for mass inauguration of the new service.

Even with the delay in introducing Il-18s and An-10s, the Russian airline exceeded its 1958 passenger traffic target by 17%.

Aeroflot began the Il-18 break-in program last August when several of the planes were placed in scheduled, short-haul (900 mi.) cargo service between Moscow and Sverdlovsk in western Siberia. More and longer Il-18 cargo runs out of Moscow were added during the fall and early winter.

By year-end, the Ilyushin turboprops were hauling up to eight metric tons of mail and freight to such distant points as Khabarovsk in eastern Siberia, Frunze and Alma-Ata in central Asia, Baku on the Caspian Sea, and Adler on the Black Sea. These points, plus many other Russian cities and several East European capitals, are expecting passenger service by 75- and 100-seat Il-18s in 1959.

Production-model Ukrainas, operating out of Kiev, started scheduled cargo-mail flights more than two months after the Il-18s. Destinations included Moscow, Sverdlovsk and Tashkent in central Asia.

Standard 84-passenger An-10s and 100-passenger An-10As are slated for regular service this year. Another version of the Ukraina—the 130-passenger An-16—is under development.

Tu-114 Service

Following the Il-18 and An-10 into service will be the giant, four-turboprop Tu-114 Rossiya. This double-decked transport, reputedly the world's largest made headlines last year by flying 21,362 mi. in 77 hr. with only three intermediate stops. Total time in the air was 48¼ hr., and average flying speed was 441 mph.

The Tu-114D's Moscow-Vladivostok Tashkent-Minsk-Moscow routing took it over the capitals of all 15 union republics. Flight legs ranged from 4,999 to 5,589 mi.

Another Tu-114D flight from Moscow to Lake Baikal and return—a nonstop distance of 5,962 mi.—bore out earlier Soviet claims that the airplane could easily fly Moscow-New York nonstop (4,662 mi.). But the Russians now admit that a 4,000-5,000 mi. stage is uneconomical even for the Tu-114.

Thus Aeroflot plans to make an intermediate stop on the Tu-114's 4,250-mi. Moscow-Khabarovsk run. The carrier explains that "with one stop, duration of the trans-Siberian trip will be increased by only an hour, or 10%, whereas passenger-mile costs will be cut almost in half because the Tu-114 could carry 170-220 passengers instead of 120."

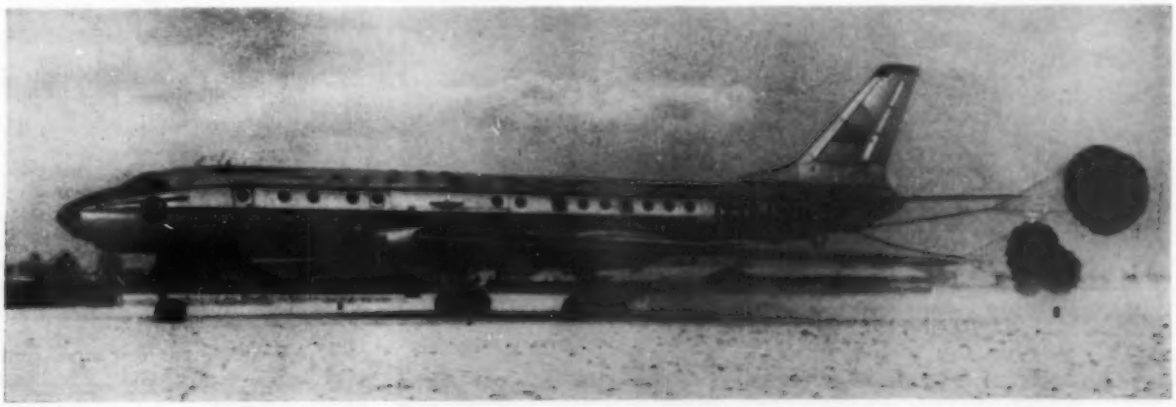
With the Il-18 and An-10 entering passenger service six months to a year behind schedule, Aeroflot is making no definite predictions when regular Tu-114 operations will begin. However, the Russians are counting on 120, 170 and 220-passenger Tu-114s to make an important contribution to Aeroflot's total capacity during the Seven-Year Plan.

Where Is Tu-110?

Mysterious "disappearance" of the four-jet Tupolev Tu-110 from the Soviet aviation scene in 1958 leaves but one new turbojet transport—the Tu-104B—to share the 1959 spotlight with the turboprops. The 100-passenger, twin-jet Tu-104B is almost identical with the Tu-104 and Tu-104A in appearance and performance. Biggest differences are the addition of 47 in. to the fuselage length, enlargement of the cargo holds, and installation of new flaps to improve landing and takeoff characteristics.

Replacement of 18 to 24-passenger, piston-engine Il-14s with 400 to 500-mph. jet and turboprop transports carrying from 70 to more than 200 passengers will provide an enormous increase in Aeroflot's seat-mile potential. Whereas the Russians rate the Tu-104 as "seven times" more productive than the 200 mph. Il-14, the Il-18 is regarded as "eight times" and the Tu-114 as "20 times" more productive.

Such figures are the basis for Soviet



AEROFLOT Tu-104 uses drag chute to cut landing run at Amsterdam, Holland. Hot landings are a problem with the airplane.

confidence that passenger air travel can be expanded "six fold" between now and the end of 1965. In this seven-year period, Aeroflot hopes to show an average annual gain of 31% in passengers carried and 29% in ton-miles flown.

Air Chief Marshal Paval F. Zhigarev, head of Aeroflot, asserts that this projected rate of growth has never been achieved anywhere in the capitalist world by any type of transportation.

Another measure of the new equipment's impact on Aeroflot's operations is the official estimate that jet and turboprop planes will fly 85% of the Soviet airline's passengers and 95% of its ton-miles in 1965.

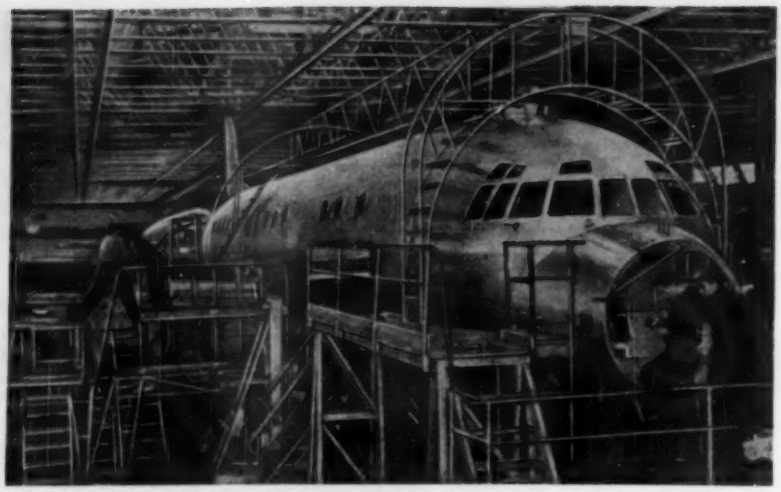
One of the Russian Seven-Year Economic Plan's major objectives is to bring the 1965 volume of production in many industries to the 1957-1958 level of U. S. output in the same fields. In the case of air transportation, this goal may come close to achievement.

Magnitude of Aeroflot's operations is still veiled in official secrecy. Until development of its new jets and turboprops, the Russian air transport monopoly's biggest boast was that it had more route mileage and flew more scheduled plane miles than any other carrier in the world. Aeroflot has also claimed to be the biggest airfreight hauler.

But when, on the basis of the sketchy figures available, Russia's air passenger traffic is compared with that of the United States, it is clear that the USSR is faced with a tremendous job of overtaking, let alone surpassing America, in the foreseeable future.

In 1940, Russia boarded 293,803 passengers on domestic routes and carried 7,510 metric tons of mail and 43,461 metric tons of cargo. Since then, nearly all statistics have been given in terms of percentage gain over previous years.

Using 1940 as a base, Russia says it handled 8.8 times as many air passengers, 5.7 times as much mail and 6.4 times as much cargo in 1956. Reduced to meaningful figures, this would be 2,585,000 passengers, 42,800 metric tons of mail and 278,150 metric tons of cargo for the year.



IL-18 MOSKVA ASSEMBLY LINE

In 1957, revenue passengers rose 69.2% to around 4,374,000, and cargo increased 21% to about 337,000 metric tons. Last year, a further 56% increase in passengers boosted the total to 6,823,000.

More Figures

Another set of Soviet figures, which apparently covers international as well as domestic traffic, indicates that Aeroflot carried about 2.5 million passengers in 1955, 3 million in 1956, 5.15 million in 1957 and 8 million in 1958.

These statistics show that while Aeroflot handles impressive quantities of cargo, it has a long way to go before reaching U. S. air passenger totals. In 1958, U. S. scheduled domestic trunklines alone flew over 40 million passengers, and the nation's scheduled airline industry as a whole boarded close to 50 million.

If Aeroflot registers another 50% passenger traffic gain in 1959, the total of around 12 million persons carried will still be below the 13.25 million handled by the U. S. scheduled airline industry in 1946.

Should Russia's Seven-Year Plan goal of increasing air passenger traffic six-fold be achieved, Aeroflot will carry around 48 million persons in 1965—2 million fewer than U. S. airlines handled in 1958.

Aeroflot's "phenomenal" 69.2% passenger traffic increase in 1957 and 56% gain in 1958 is far less impressive in terms of the rise in actual numbers of additional patrons. Thus Russia says it carried 5.5 million more air passengers in 1958 than in 1955. By comparison, the U. S. scheduled airline industry, while showing far smaller percentage gains, increased revenue passengers by nearly 8 million in the same period.

Although its foreign operations are still small compared with those of leading western nations, Russia made important international air transport advances in 1958.

During the year it concluded bilateral agreements with India, France, Belgium, The Netherlands, England and the United Arab Republic.

By year-end, Aeroflot was flying to 21 foreign capitals and was conducting negotiations for service to several other countries. Using Tu-104s and Tu-104As in competition with the piston-engine planes of other nations, Russia predicted that its "faster, more-comfortable and safer" equipment would capture considerable business from capitalist carriers in the Middle East, Near East and Europe.

Domestically, Soviet jets replaced Il-

AEROFLOT Mi-4 HELICOPTER

14s on a number of main routes including Moscow to Alma-Ata, Moscow-Vladivostok and Moscow-Petropavlovak, Kamchatka, the latter being the USSR's longest air link—5,590 mi. Il-14s, in turn, bumped obsolete Il-12s and Li-2s (Russian version of the DC-3) from trunk routes not served by jets.

Domestic route mileage, which is slated to increase by "many thousands of kilometers" during the Seven-Year Plan, rose substantially in 1958 as Aeroflot used large numbers of "surplus" piston-engine planes to provide direct service between points that formerly had only indirect connections.

Aeroflot still has no efficient feeder-liner for short-haul operations. Introduction of designer O. K. Antonov's six-passenger Pchelka (Little Bee) transport is behind schedule.

To meet some of its short-haul requirements, Aeroflot purchased "tens" of four-place, twin-engine Super Aero-45s from Czechoslovakia. However, Soviet civil aviation officials have called on the government to authorize construction of a "26 to 30-passenger plane with excellent landing and takeoff characteristics in order to permit airline service between medium and small-size towns having poorly-equipped airports."

Helicopter Service

Also in the short-haul field, Russia inaugurated its first scheduled intercity helicopter service late last year. Ten-passenger Mi-4s began flying between Simferopol and Yalta in the Crimea.

A second intercity helicopter operation—between Adler and Sochi on the Black Sea—was scheduled to start early in 1959. Helicopter service to difficult-to-reach areas of the Urals, Siberia, central Asia, the Far East and Kamchatka is planned before the end of the year.

With jets already in operation and a sizable fleet of turboprops due to begin scheduled passenger service shortly, Aeroflot will switch emphasis to ground facilities during the early 1960s. Billions of rubles have been set aside for vastly improved airports.

Under the Seven-Year Plan, capital expenditures for airport construction will more than triple in 1959-1965 as compared with 1952-1958. Ninety "trunkline" airports are to be built or rebuilt; the network of local fields will be "significantly expanded;" and airports equipped for around-the-clock operations will increase "three-fold."

Old-fashioned air terminal architecture is to be replaced by contemporary designs. Glass and concrete will be used extensively. Interiors will have fluorescent lighting and air conditioning—the latter a real innovation to most Russians.

New terminals at major cities will include one or two long passenger loading fingers. Parking lots, now practically non-existent, will handle several thousand cars. In some cases, small heliports will be built near the terminals to facilitate fast airport-downtown transportation.

Enlarged Facilities

The new Kiev air terminal, featuring a second-floor observation deck and roofed loading concourse, will have eight times the space of the present structure.

Urgent need for additional terminal space has been apparent to western travelers visiting Moscow's Vnukovo airport. Here, during peak traffic periods, over 1,000 passengers an hour pass through a structure built to accommodate Russia's relatively-light, prewar airline business.

Addition of two new wings, one for domestic and the other for international passengers, has somewhat relieved the cramped conditions at Vnukovo. Baggage handling and other terminal operations have been reorganized. Preparation of hot, in-flight meals for jet passengers leaving Moscow has been put on a mass-production basis.

Some of Russia's larger airport terminals will be designed to accommodate "several tens of thousands of persons daily." Standardized in many respects, the buildings will be completed in stages as the need arises.

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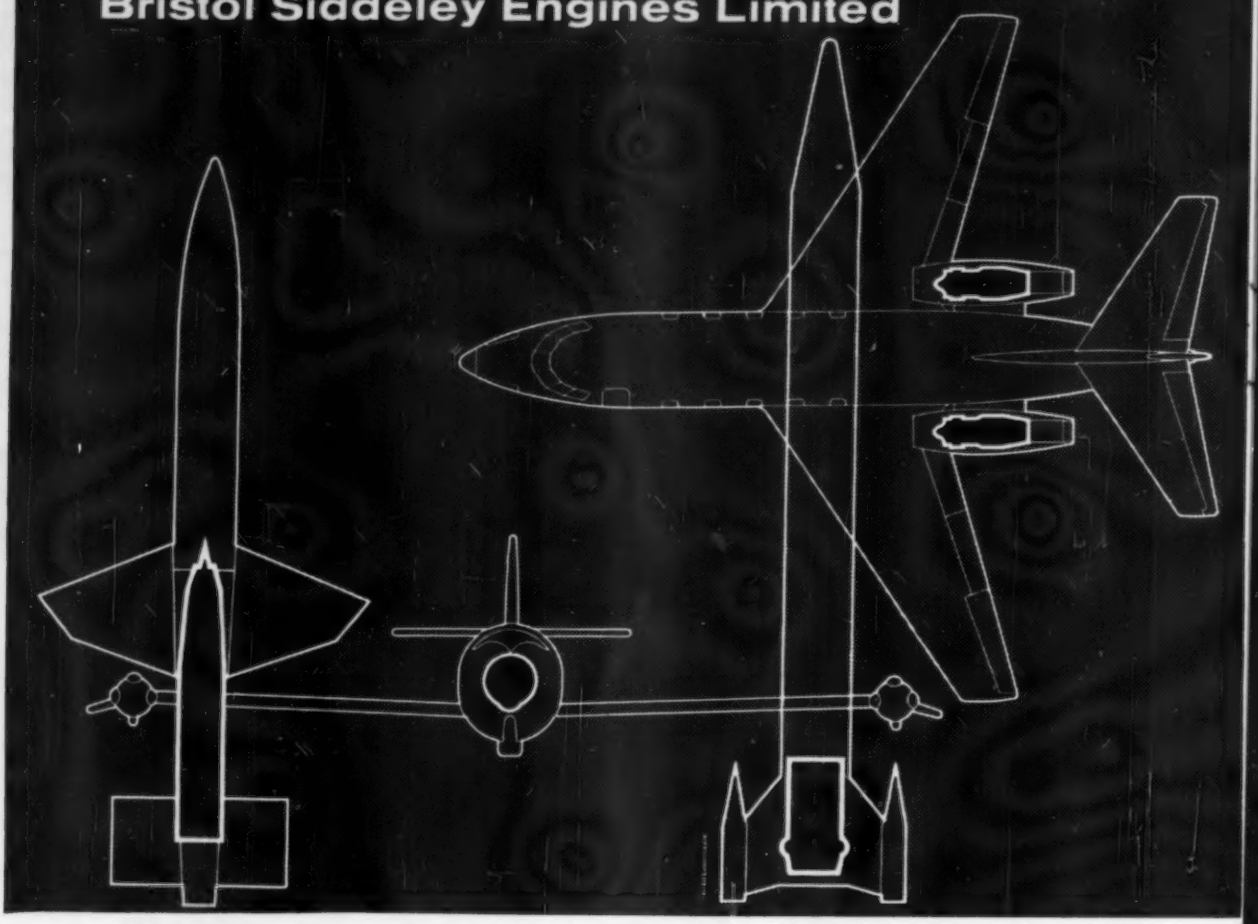

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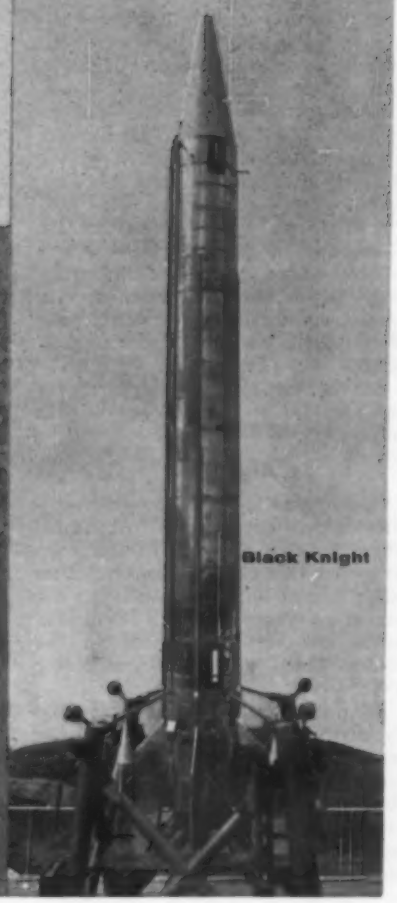
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Nations Scramble to Fill Bigger Fleets

Airlines throughout the world last year fought with expanded piston fleets for traffic that increased, but at a slower rate, during the interim before the full-scale jet age.

Many carriers received the last units of their piston aircraft orders and total capacity offered outran the available traffic, resulting in load factors which in many cases were down, at least to some extent. Routes were expanded and the battle for traffic rights under bilateral agreements continued its sharp tempo.

A major issue before the airlines last month was the question of fare differentials between piston and turboprop versus jet aircraft. Resolution of this conflict was certain to have far-reaching effects on the character of the airlines' jet age.

Among the 1958 developments in world airline operation were the following:

Argentina

Four commercial airlines were regularly active last year in Argentina, where privately financed carriers were struggling to establish themselves after being banned for some years under the former government of Juan Peron. Political and economic unrest in the country added to their problems during 1958.

Biggest carrier of airline traffic was the state-owned Aerolineas Argentinas, with a 1958 total of 482,498 passengers and a passenger load factor of 64%. Aerolineas operated at a deficit for the year of $3,768,082. The airline will receive three of an order of six de Havilland Comet 4 jets this year an expects to begin jet service to the U. S. and Europe this spring.

Privately owned Transcontinental S. A. completed its second year of domestic operation with converted C-46 equipment and last fall opened service to New York with Lockheed Super H Constellations. Transcontinental carried 143,138 passengers with a load factor of 54.7% and 6,075 tons of freight with a load factor of 61%. Deficit for the fiscal year ending in March is estimated at $1.5 million.

The airline has four Convair 880 jets on order for 1961 delivery, hopes to extend its routes to the U. S. West Coast and on to Tokyo.

Belgium

Sabena Belgian World Airlines carried almost a million passengers in 1958, raising its total of the previous year by about 300,000. A strong stimulant to Sabena's traffic was the Brussels World Fair. This exhibition boosted Sabena's helicopter services, which carried 15,000 passengers over its routes from France, Germany and Holland and another 65,000 passengers on sightseeing flights.

Sabena received the final two Douglas DC-7Cs last year in its order of 10 and expects to receive its first of Boeing 707-320 jets this year. Adding leased Super Constellation equipment to its transatlantic fleet of DC-7Cs, the airline carrier 39,976 passengers across the North Atlantic last year, increasing its share of this market from 3.8% to 6.9%.

Brazil

Brazilian commercial aviation reportedly had a bad year in 1958 although actual statistics will not be available until later this year. According to preliminary reports, all Brazilian airlines except Varig were operating in the red last year.

Proposed jet aircraft purchases reportedly may be delayed. New equipment going to Brazilian carriers this year is composed of five additional Viscounts for VASP Airlines and three Caravelles for Varig. Financing for these aircraft already has been arranged.

Canada

Early this year the Canadian government revealed a long-awaited decision on competitive service on the transcontinental air routes, until then a monopoly for the government's Trans-Canada Airlines. Now Canadian Pacific Airlines will be able to fly one daily service each way between Vancouver, Winnipeg, Toronto and Montreal.

The government followed the recommendations of its Air Transport Board, which after extensive public hearings last fall, recommended the one flight daily to strengthen CPA's services in the international field. CPA operates to Mexico and South America out of Toronto and Vancouver, from Vancouver to the Orient, Australasia and Europe, and from Montreal to Portugal and Spain.

Canadians will also have a chance at a competitive airline between major cities.

The situation is to be reviewed in two years, when CPA can again apply for more services. It had applied for five routes across Canada, covering various cities.

Both TCA and CPA are readying for a competitive struggle, and both have ordered new aircraft for their present services, some of which will be delivered late this year. TCA has orders for four more Viscount aircraft a Super Constellation for early 1959, will receive delivery of the first of six DC-8s late in 1959, and the first of 24 Vickers Vanguards early in 1960. TCA now has 46 Viscounts in service along with 12 Super Constellations, as well as other aircraft. By 1961 TCA expects to be the first airline in the world to have only turbine powered aircraft in use.

CPA is now operating six Bristol Britannia aircraft on its routes from Vancouver to Europe via the Polar route, to Honolulu and Tokyo and Hong Kong. It has 15 Super DC-6B aircraft on these and other services to Australia, New Zealand, South America, Mexico, Portugal and Spain. It plans to use DC-6B aircraft on domestic Canadian routes and to use more Britannias on its international routes.

France

Most important event during 1958 for French air carriers, both state-owned and private, was the expected denunciation in July of the 1946 Franco-American bilateral. The French this year expect to negotiate a new bilateral which, among other things, would give state-owned Air France landing rights on the U. S. West Coast.

French also hope a new bilateral may open U. S. gateways to France's two main private carriers, Transports Aeriens Intercontinentaux (TAI) and Union Aeromaritime de Transport (UAT).

TAI presently holds exclusive rights among French carriers to routes beyond Saigon to Australasia, and Tahiti. The carrier wants to carry traffic from Australasia to the U. S. West Coast, perhaps via Honolulu.

UAT, largest French private airline which operates mainly between French and African points, would like to enter the Miami gateway via a route which would originate in Johannesburg and stretch to Miami via Dakar and French possessions in the Caribbean.

TAI and UAT would use Douglas DC-8 jet liners on these new routes. Each carrier has two DC-8s on order.

Air France officials are hoping for Los Angeles or San Francisco as their West Coast terminus on either a polar route or an extension from eastern U. S. points. Ideally, the French would like the U. S. to match each Fifth Freedom route it gets from France (for TWA and Pan American) with a like route in the U. S. for Air France.

On the basis of incomplete 1958 figures, French carriers report a successful year. Air France ton-miles were up 5%; its passenger-miles, 7%. Passengers carried totaled 2,510,000. System wide load-factor was 66%.

FIRST AEROLINEAS COMET 4

On May 15, Air France will begin service with the medium-range Sud Aviation Caravelle jet transport. Current plans call for initial Caravelle service between Paris and Near East points; later in the summer Caravelles will be put on a Paris-London-Nice route. Company also expects to fly the Caravelle biweekly between Paris and Moscow with a stop at Warsaw. Air France presently serves Moscow nonstop from Paris with Super G Constellations on biweekly basis.

During the peak North Atlantic season this year, Air France is planning 28 weekly flights, 23 between Paris-New York and five between Paris-Montreal. Company's Paris-Tokyo polar route will be operated biweekly beginning in March. Passenger total on the North Atlantic last year was 90,569, up from 75,241 in 1957.

TAI passenger-kilometers in 1958 were up 11% from 1957, its ton-kilometers increased 10%. The carrier racked up 26,580 flight hours on its own system, plus an additional 6,633 hr. on charter flights for Sabena, Air France and Air Algerie. During 1958 TAI carried 74,847 passengers on its system, an increase of 19% over 1957.

Company presently is having some difficulty with Australian and New Zealand authorities over landing rights for its three DC-7Cs. This has kept TAI from fully exploiting its new equipment on its own route. It wants to clarify its position in Australasia before delivery of its two DC-8s in June-July, 1960. TAI, in hopeful anticipation of getting U. S. landing rights on the West Coast, recently opened a Los Angeles office.

UAT during 1958 continued to develop its cargo runs between France and Africa along with its growing passenger service. Preliminary estimates of the carrier's cargo ton-kilometers during 1958 are 18 million, 15% over 1957. UAT also continued to increase its passenger business between French and African points, particularly between Paris and French West Africa. Carrier's main fleet consists of nine DC-6Bs, some of which are used in cargo configuration. Company also operates seven Nord Noratlas cargo-passenger aircraft and seven de Havilland Herons on its internal African routes.

UAT, largest of the French private carriers, expects delivery of its two DC-8s during 1960. The carrier already has some jet experience, having used Comet 1s.

Air Algerie, also a private carrier, continued to benefit during 1958 from the increased traffic resulting from the Algerian war. Passenger traffic in the first 10 months of 1958 was up 17% over the like 1957 period. In the same period, the carrier's cargo and mail ton-kilometers registered a sharp increase of 55%. During 1958 the carrier placed orders for four Caravelles.

Attempt during 1958 to launch a domestic air service within France failed. Grouping of all French carriers, together with SNCF, French National Railways and several banks, was unable to bring off the scheme. After several months of operation between French cities the new airline—Air-Inter—ceased operations. Apparently not enough traffic was generated to justify the heavy operating costs.

Germany

In its fourth year of post-war operation, fast-growing Lufthansa German Airlines expanded its route system 50% and increased its total of passengers carried 45% to 622,500.

Traffic on its European segments was up 60%; North Atlantic increase was also 60%; Near East routes showed a 33% gain and domestic traffic within Germany was up 20%.

Lufthansa flew 98,915,364 ton miles, an increase of 51% over 1957. Cargo rose 70% to 5,602 tons, mail increased 36% to 2,102 tons. Passenger load factor for 1958 was 53.6%, down from 57.2% in 1957, reflecting the airline's absorption of new routes including services to Cairo, Chile, Brussels, Rome, and Brazil. Fleet additions during the year included delivery of three of nine Vickers Viscount 814s. Lufthansa has four Boeing 707-420 jets on order with plans to begin jet service in spring, 1960.

Further route expansion is planned this year, with services to Athens, Manchester, Milan and Stockholm scheduled to begin next month, and services to Barcelona, Geneva and Nice planned in May.

In the North Atlantic operation, Lufthansa carried 54,413 passengers in 1958, including 32,134 economy class customers.

The airline's overall 1958 load factor was 50.3%, compared to 53.1% in 1957.

Great Britain

Most significant issue during 1958 to British airlines and aircraft industry was the controversy over fare differentials between jet and other aircraft. The industry is heavily committed to production of turboprops.

Strong advocates of a fare differential structure were the Ministry of Transport and Civil Aviation, British European Airways and virtually the whole of the aircraft industry. British Overseas Airways Corp., more heavily committed to turbojets, was less emphatic on the issue.

British European Airways registered a record net profit of $3 million during its financial year ending Mar. 31, but showed poorer results for the rest of 1958. Total revenue was up 10% to $85.9 million, but passenger capacity was up 13.1% to 961,242,000 ton miles and passengers carried were up less than 1% to a total of 2,760,000. Over-all load factor for the year was 60.1%. Passenger load factor was down 11.1% to 62.3%.

BEA retired the last of its piston

planes in July 10—Elizabethans—and became the first airline to operate an all turbine fleet on its external routes with 74 Viscounts. BEA now has the largest fleet of gas turbine aircraft in the world. According to Vickers, the Viscount carried 34% of the total intra-European air traffic last summer—12% more than any other aircraft.

Clipped wing Comet 4B will begin BEA service in the autumn and will be put on the Rome, Athens, Istanbul, Geneva routes principally to meet the United States jet challenge.

Delivery of its Vanguards should begin early in 1960 and BEA hopes to have 10 Vanguards operating on its high density routes by the end of that year.

By the end of February the airline had received its sixth Comet and delivery of the final 13 is expected this year. In April, BOAC Comets will take over from the Bristol Britannia on BOAC's Far East service to Hong Kong and Tokyo, and on the Australian and South African routes later this year.

By December last year BOAC had put the whole of its Britannia fleet into service. The long range 312 version was used to extend its transatlantic service to San Francisco, Detroit, Chicago, Montreal and to Caracas and the Caribbean.

Britannia 102s relieved by the Comet on the Far Eastern routes will be switched to the West African routes during April this year and complete an all Britannia service to Africa. This will remove the last Stratocruisers from BOAC service. All but two of these planes were handed back to Boeing Airplane Co. in a trade-in jet deal. BOAC has sold its Constellations—but had still its Argonauts to dispose of. By the end of this year the only piston engined aircraft operated by BOAC will be its DC-7C fleet, sharing the Atlantic and transamerican routes.

These aircraft, together with the Comet and Britannia, will be replaced by the Boeing 707-420 jets from December this year onwards. First Comets to be relieved on the Atlantic will then be used to open the old BOAC route to South America.

BOAC has declined to issue estimates of total revenue for the last calendar year, but apparently it is still likely to be well in the red. Last year it suffered a net loss of $7.8 million.

Total passenger miles flown by BOAC were 1,431 million, up from 1,319 million last year which total just about matched the increase in capacity offered.

Holland

KLM Royal Dutch Airlines earned $3,292,000 net income last year on total operating revenues of $129 million. It carried 940,000 passengers last year, an increase of 27,000. Two important route additions were made during the year, an Amsterdam-Moscow service and a polar route to Tokyo. Two other cities, Kuala Lumpur in Malaya and Tripoli in Libya, also were added to the KLM network in 1958 to bring its total to 105 cities in 74 countries.

At the same time, KLM lost its route between Amsterdam and Jakarta, Indonesia, because of political developments.

The Dutch airline added five DC-7Cs and three Lockheed 1049H Constellations to its fleet during the year. Delivery of 12 Lockheed Electra turboprops is scheduled during 1959, and the airline expects its first of eight Douglas DC-8 jets early next year.

To help finance the jet orders, KLM planned to offer $17 million in convertible debentures due in 1979, on the New York and Amsterdam exchanges.

Italy

Alitalia, finishing its first full year of operation after merging with LAI, was in the van of jet surcharge proponents in 1958 in the International Air Transport Assn. controversy. Alitalia flew 411 million passenger miles during the first 11 months of 1958, an 18% increase over the entire 1957 total for both carriers before the merger.

Passengers carried by Alitalia in 1958 totaled about 600,000. The airline formerly handled Italy's domestic routes with LAI flying the Atlantic run. Transatlantic passenger total last year for Alitalia was 26,425, up from a 1957 Italian flag total on the run of 12,161.

Alitalia received the last units of its Convair 440 and DC-7C orders last year, now has a fleet of 10 Viscounts, six DC-7Cs, six 440s, and 11 DC-6Bs. Six Douglas DC-8 jets are on order for early 1960 delivery.

There were no major additions last year to the airline's route structure. Among 1959 plans are services to Karachi and Bombay, and the inclusion of London on the route to North America.

Japan

Japan Air Lines went forward during 1958 with an expansion program which it hopes will result in an around-the-world jet service within the next four years.

The airline carried 72,277 passengers and flew 185 million passenger miles on its international routes during the year ended Sept. 30, 1958. The domestic totals were 399,155 passengers and 175 million passenger miles.

The Japanese carrier stepped up its transpacific schedules last April from five to seven weekly with the delivery of additional DC-7C aircraft. The airline's route to Bangkok from Tokyo was extended to Singapore, and survey flights to Sao Paulo, Brazil, were increased to bi-monthly and offered as scheduled services.

Japan Air Lines has ordered four Douglas DC-8 jet transports and is considered to have government political and financial backing for any additional jet orders it decides to place. Meanwhile, it plans to inaugurate transpacific service to Los Angeles in May and to Seattle in June.

Scandinavia

Scandinavian Airlines System earned $105,463,000 in total revenues during the year ending Sept. 30, 1958, an increase from $96,081,000 during the previous like period. Total costs for the 1957-58 period were $105,463,000, including an additional depreciation allowance over the regular such costs for a depreciation total of $9,459,000. Costs for the previous year were $94,054,000.

SAS last fall entered into a highly significant arrangement with Swissair under which the two carriers will lease jet equipment to each other and pool their maintenance and overhaul. Under the agreement, Swissair will lease two of its five Convair 880-25 transports, scheduled for delivery late next year, to SAS for a four-year period. SAS in turn will lease four Sud Aviation Caravelle jets to Swissair for a like period. The Scandinavian carrier increased its Caravelle order by four to a firm 16, with first deliveries scheduled.

The agreement calls for Swissair to maintain both carriers' Convairs and engines, and SAS to maintain the Caravelles and the Douglas DC-8 jets and DC-7Cs which both airlines have bought. Both carriers thus will have common jet fleets and complementary route structures, with Caravelles handling European runs, Convairs on medium routes, and DC-8s on the North Atlantic.

The SAS-Swissair arrangement, providing an approach to the vital problem of cutting jet-age costs and financial investment, is considered of great interest to other European carriers.

SAS carried 1,510,000 passengers over its system in 1957-1958, up from 1,396,000 passengers in the previous fiscal year.

The airline is entering its third year of polar route service between Copenhagen and Tokyo, and its fifth year over the West Coast-Europe polar route, both of which it pioneered. Last year on the North Atlantic SAS carried 118,088 passengers, up from 87,000 the year before. It was the first airline to eliminate the tourist class when the economy fare went into effect on the North Atlantic last April, and it carried 88,168 passengers in the new fare class.

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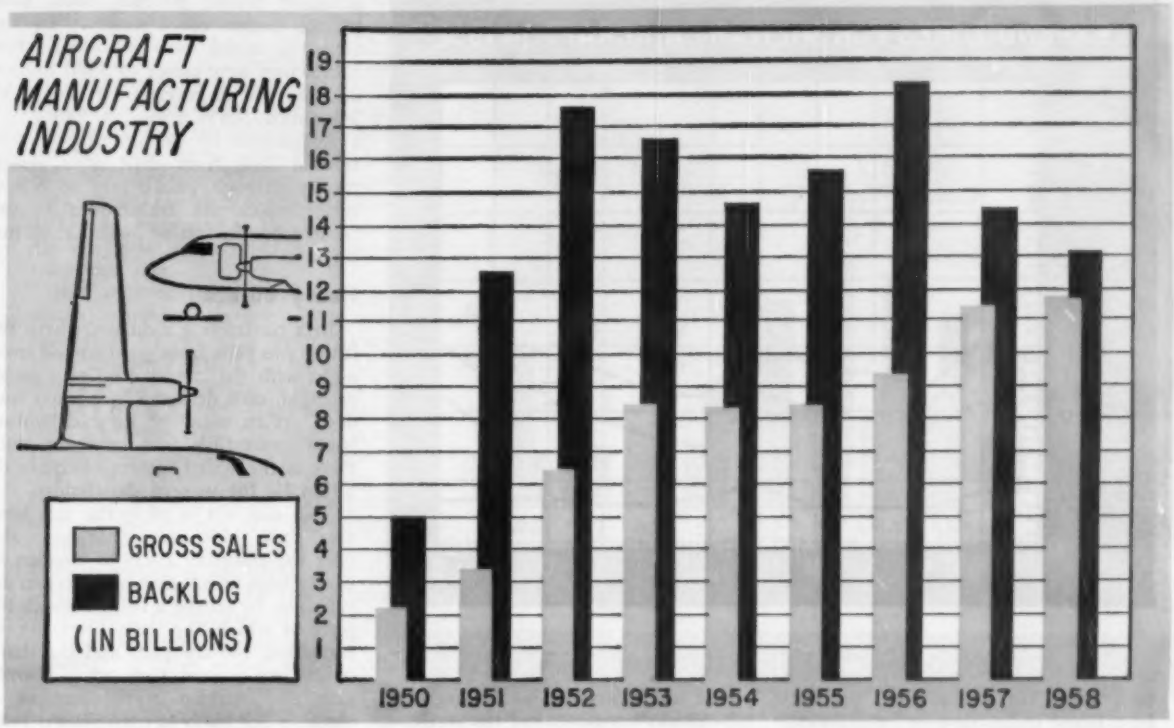


Economics Lags in Technological Race

By William H. Gregory

New York—Aviation enters 1959 with over-all market prospects that seem disarmingly stable when compared with the uncertainty facing individual companies caught in the cross currents of swiftly changing technology and the not-always-successful efforts of economics to cope with them.

Military sales of aircraft, missiles and space vehicles for the calendar year 1959 should closely approximate the $10.3 billion estimate for actual expenditures in 1958. With increased deliveries of commercial jet transports this year, total sales of the industry will be over $12 billion.

Changeover to missiles, heralded as a revolution in the industry, is only one of the many problems the industry faces. The basic economic problems:

• **Fewer, more expensive** weapons are being bought. This means fewer programs and a more intense competitive scramble for them.

• **Increased research,** if it does in fact increase, will accelerate the already rapid rate of obsolescence in weapons systems. Existing systems only just maturing in development will find themselves displaced by even more potent ones appearing on the horizon.

• **Fixed level** for military expenditures as administration policy will force stretchouts and cancellations of older systems to provide support for newer ones. Dropping of Chance Vought's Regulus II airbreathing missile because of development of the Lockheed Polaris solid propellant submarine-launched ballistic missile last year and the siphoning of money from various programs to fund the fast moving Minuteman solid propellant ballistic missile for USAF are signs of this trend.

Finding a satisfactory product mix to cope with the situation is becoming an elusive thing for companies.

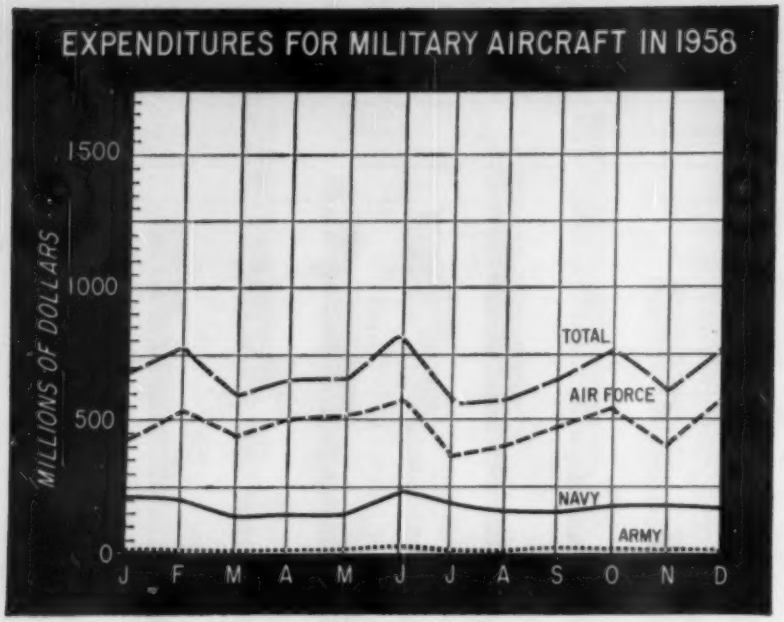
For military business, in essence serving a single customer responsible for about 85% of the industry's total sales, this means providing a broad spectrum of scientific capability. Because of the increased cost and complexity, neither the military nor the company may be able to afford to develop a prototype vehicle for a major weapon system. Thus the military may buy a company rather than a product, with a natural result past performance on major weapons becomes an important factor. Competing for prime systems contracts is tough for newer, but ambitious contractors.

Though a slow process, the excess of plant capacity and possible elimination of some contractors that Air Force leaders as Gen. C. S. Irvine have warned was impending seems to be coming to pass. Changes to compensate contractors for their increasing problems and to provide greater reward for the more efficient have been discussed and some action possibly may result in Congress this year.

One result has been the appearance of the team proposal. By combining, companies can furnish the broad technological capability and experience—especially in avionics—they may not have been able to offer singly.

Commercial business as a way to add to the product mix had its own pitfalls. None of the five companies building new turbine engine transports—Boeing, Douglas, Convair, Lockheed or Fairchild—have reached the break-even point covering full development costs. Intense competition for sales has led to such radical measures as accepting trade-ins of used airplanes, a potentially uneconomic device.

Other companies which have followed military urging to invest more of their



own funds in off-the-shelf products have found orders slow in forthcoming.

Economic problems trailing in the wake have come in myriad shapes.

• **Profit margins** have declined slowly but steadily from 3.7% of sales in 1954 to 2.4% in 1957 and 2% last year. Increasing cost-plus research and development type contracts and tougher procurement policies contributed strongly as causes.

• **Competition** is becoming tougher not only for prime contracts, but also for subcontracts. Traditional subcontractors find themselves competing with companies that traditionally held prime contracts; shifting into new technologies forced many companies onto unfamiliar ground and left others with idle plants.

• **Fixed assets** tend to grow with government insistence on more company financed research. Though there is excess plant capacity, especially high bay airframe plants, new capacity must be built for development of new weapons at inflated construction costs.

• **Debt is rising,** both short term bank and long term public borrowing. Broadening of the equity base, that is sale of additional common stock to the public, appears desirable to some companies, but the industry's other economic problems have caused aircraft securities to lag behind the broad market rise experienced by industrials as a whole in 1958. Historically, aircraft company listings have not been frequent on the New York bond market, but early this year Boeing, Chance Vought, Douglas, Lockheed, Martin and Northrop issues all could be found.

• **Restriction** on progress payments have placed added demands on working capital. Slower payments and the resulting rise in receivables has, along with capital investment, led to the aforementioned rise in borrowing.

• **Renegotiation** has trimmed profits of companies at a critical time when they are faced with heavy demands for capital and competitive pressures. One company reports spending $600,000 alone on a recent unsuccessful bid. Interest costs also have nicked into the profits.

The natural tendency in times of turbulence is to dwell on the troubles. But the industry also has some solid factors on the plus side.

• **Industry** has been able to cope with the increased financial demands made upon it and still carry out its technological mission.

• **Aviation's market,** despite the changes, is still a vast one and total industry employment, though declining, is approximately 760,000 persons.

• **Backlogs,** though declining also, stood at $13.1 billion as of Sept. 30, 1958.

• **Earnings** have declined—drastically for some companies—but the industry has shown a capacity for remaining profitable in a time of depression and financing troubles plaguing its military customers.

• **Aviation** has demonstrated its utility to business on the business man's terms. This solid and increasing growth of business flying is a development whose significance should not be underrated.

When cutbacks and stretchouts first generated an economic crisis in the industry in the last half of 1957, it looked for a time as if borrowings might reach a billion dollars, probably more than private lenders could supply. By the time the initial wave subsided, actual borrowings were closer to $300 million and the talk of government backed V-loans died. (AW July 7, p. 54.)

Acquisition by the industry of substantial long term debt as a result, mostly through public sale of debentures, which are tantamount to unsecured bonds, can be looked at in two ways.

Heavy Burden

In a contracting industry, where the future can turn from good to bad overnight with the cancellation of a major program, such debt can be a heavy burden. With many of these debenture issues convertible into common stock there is the added specter of equity dilution for the present shareholder.

This may not be all to the bad, however, since these convertible issues also offer the company a way to broaden its equity base which may have certain advantages. By setting a floor, through the price at which the debentures can be converted, the company and the shareholder are assured that actual conversion and increase in the number of shares is not likely to occur unless there has been a worthwhile rise in the price of the stock. Since the conversion price is at worst the current price of the stock, the company and the shareholder have a hedge against the future. If the price of the stock drops, the debenture holder is likely to simply hold on to his debentures until they mature and not convert them.

The company might do better to sell shares outright, but market peaks are quite difficult to determine except in retrospect.

Debenture Issues

Regardless of the pros and cons, most aircraft and airline public financing has involved debentures. These issues have been generally successful and some are selling at a premium. Boeing and Douglas both were able to complete major financing for their commercial jet as well as military programs. The Douglas issue turned out to have been especially well timed. It was a relatively early one and came at the time when Douglas stock was selling around $90 a share. Since then uncertainties have plagued the aircrafts and Douglas has dropped to below $55 a share.

Another example of debenture financing is Kaman Aircraft Co., which sold a $1,250,000 convertible issue early this year.

At 6% interest, this financing is not cheap, but the company appeared to find the opportunity to broaden its equity base in this manner more desirable than an outright sale of stock.

Broadening of the equity base is

likely to get increased attention this year, both by manufacturers and airlines.

Manufacturers are concerned because one disputed issue in the debate over renegotiation has been profit margin. Figured on sales by the industry, profit margins have been well below nondefense industries. Military producers, for example, cite their 2.4% margin on 1957 sales compared to the 5.9% average return by all major U.S. manufacturers that year.

But profit margin for airframe companies, computed on net worth, averaged 17% for the years 1946 through 1957 compared with 14% for all U.S. manufacturers, according to Aircraft Industries Assn. figures. The Renegotiation Board has cited this factor as an argument for continuation of renegotiation. To that the industry replied at House Ways and Means Committee hearings last summer that the general youthfulness of the industry plus its financial problems, including renegotiation, made it difficult for the industry to broaden its investment base and make capital improvements.

Reinvestment is a sore subject with the industry. In a recent talk in New York, C. J. McCarthy, chairman of the board of Chance Vought, pointed out that the industry had the highest reinvestment rate of any, returning approximately 60 cents out of every dollar earned in research, facilities and equipment.

Hearings are scheduled again on the subject of renegotiation this year, since the act was only extended for a year in 1958. In the meantime Boeing Airplane Co. has launched a major offensive against renegotiation in the courts, resumption of case is set for June.

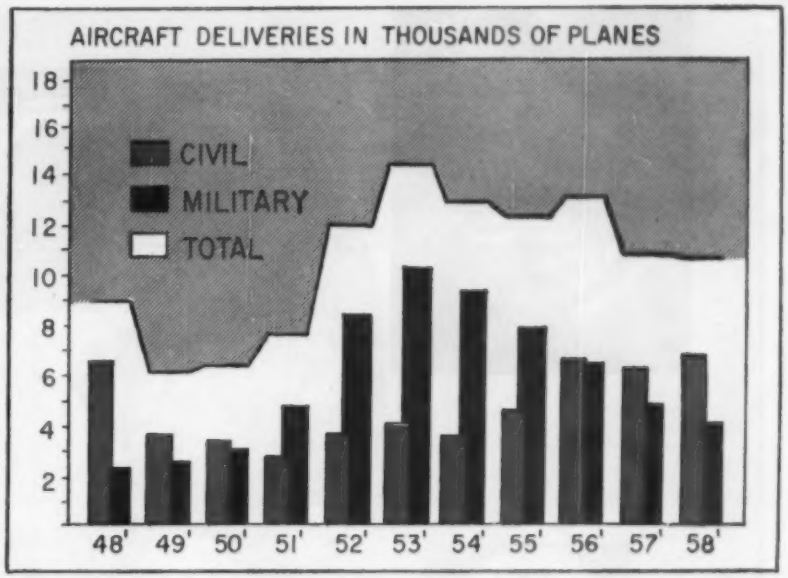
Airline Problems

Financing by airlines of their $2 billion in turbine equipment orders not including spares, of major concern to manufacturers, is now completed for the most part, but a critical factor is the cash flow generated by operating revenues.

This cash flow is based on varying traffic estimates, but all would undoubtedly be affected by a recession and slow down in the growth curve as that occurring last year. Increased competition is exerting a more and more severe effect and could also upset revenue forecasts. Thus there is an area of uncertainty in the latter stages of new equipment deliveries.

Trans World Airlines is a big question mark since its orders all are in the name of Hughes Tool Corp., which controls the airline.

How manufacturers are affected is shown in the case of Convair, which not only has a major part of its orders for its 880 jet transport from TWA but



Production and Related-Worker Employment

U. S. AIRCRAFT INDUSTRY (In thousands)

	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total
1958*	291.3	89.9	12.2	85.8	479.2
1957	350.7	108.2	14.0	101.5	574.6
1956	329.8	104.4	11.3	95.3	540.8
1955	330.0	94.5	9.3	80.1	513.9
1954	343.2	105.9	11.5	89.8	550.5
1953	347.8	126.5	13.2	89.3	576.8
1952	311.6	98.8	10.4	62.7	483.5
1951	232.3	63.7	7.6	38.3	341.9

Total Employment

1958*	456.8	152.7	18.3	129.7	757.5
1957	537.5	174.3	20.5	145.8	878.1
1956	499.1	165.6	16.9	132.8	814.4
1955	482.2	145.6	13.7	109.4	750.9
1954	497.8	166.8	16.1	125.2	805.6
1953	479.1	177.3	18.0	115.9	790.3
1952	425.9	138.8	14.5	81.6	660.7
1951	313.3	90.8	10.8	48.8	463.6

Average Hourly Earnings of Production Workers

1958*	$2.51	$2.54	$2.38	$2.49	$2.51
1957	2.35	2.39	2.35	2.37	2.36
1956	2.27	2.28	2.27	2.29	2.28
1955	2.17	2.17	2.18	2.17	2.17
1954	2.08	2.09	2.09	2.07	2.08
1953	1.99	2.03	2.03	1.99	2.00
1952	1.87	1.98	2.05	1.88	1.90
1951	1.75	1.89	1.93	1.80	1.79

* Preliminary Figures.

SOURCE: Bureau of Labor Statistics.

Flexible Hose: Metal, Synthetic, Flexon-T (Teflon)
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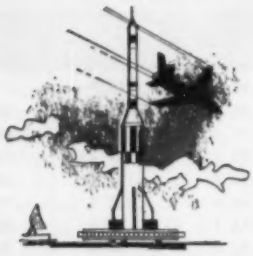

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Airline Jet Financing

The following figures show the latest reported status of airline financing for jet equipment. The totals are for aircraft and engines only, plus some spares. Borrowing is broken down to indicate straight borrowing from banks or insurance companies; the "other debt" column is to indicate borrowing which may involve sale of securities publicly, or in several cases to institutions, and involving eventual distribution of common stock. The airline figures may not add because of overlap of loans and deposits.

Airline	Bank or Institutional debt		Other debt	Deposits or deliveries	To be paid from cash flow, depreciation, etc.	Total
	Total	Unused Remainder				
American	$135,000,000	$85,000,000	$80,000,000 (engine leases)	$79,000,000	$201,000,000	$445,000,000
Braniff	40,000,000	25,000,000	.....	11,499,000	.....	56,500,000
Capital	42,905,000	.....	12,000,000	.....	.....	45,000,000*
Continental	.....	.....	12,500,000[1] (debentures)	28,818,000	.....	51,381,000
Delta	60,000,000	.....	.....	19,000,000	25,000,000	74,000,000
Eastern	50,000,000	.....	25,000,000 (conv. note)	28,000,000	132,000,000	235,000,000
National	40,000,000[2]	17,000,000	.....	11,300,000	30,700,000[6]	59,000,000
Northeast	.....	.....	.....	.....	.....	.....
Northwest	72,500,000	.....	11,000,000 (conv. preferred stock)	1,447,465	16,500,000	67,500,000[4]
Pan American	220,000,000[1]	61,300,000	.....	89,000,000	77,000,000	212,000,000
Trans World[3]	.....	.....	.....	21,000,000[5]	.....	370,000,000
United	130,000,000	.....	120,000,000 (conv. debentures to insurance companies. $80,400,000 sold)	57,700,000	.....	275,000,000
Western	6,000,000†	.....	.....	4,200,000	7,500,000	20,000,000
Total	$796,405,000	$188,300,000	$260,500,000	$350,964,000	$489,700,000	$1,865,381,000

Footnotes:
1. Only part used for jet equipment.
2. $15 million of this to retire existing interim bank loans.
3. Orders in name of Hughes Tool Co.
4. After trade in of Stratocruisers and DC-7s.
5. Reported paid to Convair for full price of initial airplanes.
6. Estimated.

† Some previous loan funds available.

* Capital hopes to negotiate firm orders for 10 Convair 880s. Value indicated not included in total. Loan figure is for Viscounts.

also is negotiating with Capital, which is heavily burdened with payments for its fleet of Vickers Viscounts.

General Dynamics retired an issue of debentures over a year ago and financial interests are expecting the parent company of Convair to seek some new financing soon to handle the developments costs of the transport, the last of the jet transport builders to do so.

One of the strongest jet financing programs is United's. The airline can borrow up to $250 million and has already paid $57 million in deposits on jet orders currently amounting to $275 million. Although United is expected to order more airplanes, on the present basis it could either not take down all its loan commitments, saving interest costs, or it could take the full amounts and use its cash reserves for other purposes.

Like the manufacturers, the airlines have had their problems with the government.

In their case, however, it has been with government regulation and not contracts.

Attacks by airlines and the financial community on Civil Aeronautics Board policies on what they term indiscriminate route awards and on undue delay in reaching a decision on fares grew much more pointed during the year. Though the airlines reported better earnings at year end, these often were due simply to a change in accounting procedures on depreciation which arbitrarily added to the profit side of the earnings report.

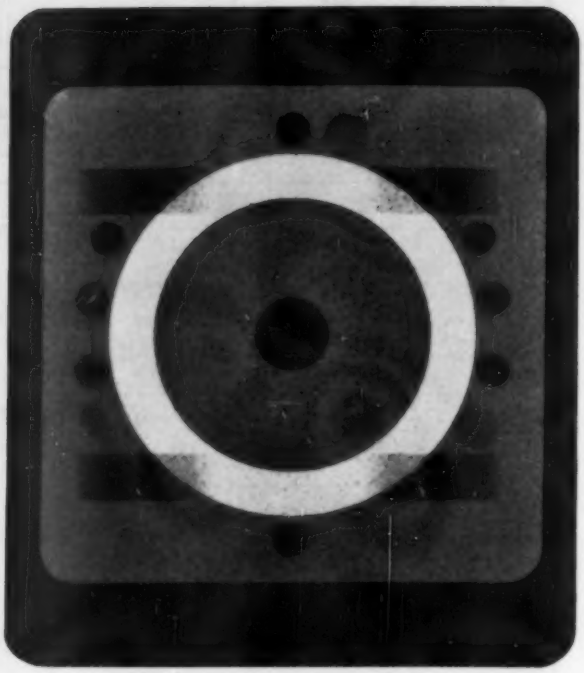
Investment houses showed a cautiously favorable attitude toward selected airline stocks and prices rose enough in the last few months to cause a few airline executives to show interest in seeking new equity financing. The rise appears to be largely based on long term optimism; though cash flow probably will remain high, retirement of heavy loans for new equipment is unlikely to leave much in the way of earnings.

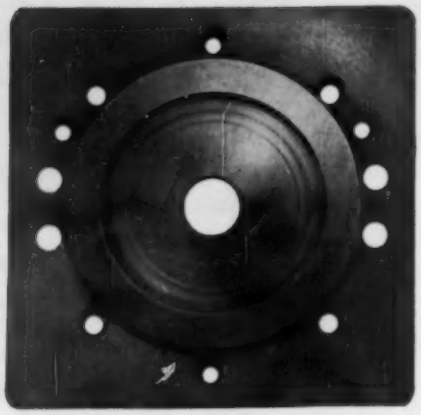
Pressure on airlines for equipment purchases brought an upsurge during the year of efforts to interest operators in leasing as an alternative to buying. Airline response was reluctant, though American did enter into leasing agreements with three manufacturers for engines.

The potential for this method of financing equipment for airlines is still to be tested.

Local service airlines, also attempting to re-equip either with Fairchild F-27s or piston equipment more modern than DC-3s, were able to arrange loans through the Guaranteed Loan Bill for the first time last year.

Radiograph shows porosity which caused markings to be fuzzy





Alloy casting for faceplate of aircraft instrument

End of a fuzzy face

SEE-AT-A-GLANCE clarity is an absolute *"must"* for aircraft instruments. So when one in development appeared with fuzzy numbers and index marks on its face, the cause and cure had to be found.

Sperry Gyroscope Company maintains a large and efficient x-ray testing department, hence the casting for the instrument face was promptly radiographed.

What the radiograph revealed was marked porosity. The conclusion was that the material used in applying the figures was being absorbed and sharp delineation was impossible. Therefore, a change in casting technic was indicated.

This is typical of the ways radiography helps the foundryman make sure only satisfactory work is delivered—make sure he is building and keeping a reputation for high-quality castings. If you would like to know how it can help you, call your x-ray dealer—or the Kodak technical representative—and talk it over.

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Research Scores Gain On Heat Problem

By Michael Yaffee

Metallurgists last year registered some of the most significant technical gains of the past quarter-century in the development of high temperature, high strength and light weight materials for the aviation industry.

Among the more notable advances were those resulting from the combined military-industry effort to raise the useful operating temperatures of aluminum and magnesium, two of the lightest and best known aircraft structural materials.

Most of the current aluminum alloys are designed for use at temperatures below 400F; a few, such as aluminum alloy 2219, are useful to about 600F. But some recent developments now show promise of extending aluminum's serviceability to almost 1,000F. One is the addition of powdered aluminum oxide to an aluminum base material. Another is the reinforcement of the aluminum matrix with glass fibers.

Thorium Addition

In the case of magnesium, the addition of thorium, as in the alloys HK31 and HM21, has extended the useful temperature limit of the material to approximately 900F.

At these 900-1,000F temperatures, aluminum and magnesium alloys may stand up only for short times. But the important thing here is that metallurgists have now advanced the operational temperatures of these two materials almost to their melting points. For most metals, the service temperature is figured roughly at one half of the melting point, or slightly better.

Another lightweight metal of great interest to the aircraft industry and military is beryllium. Its density of 0.66 lbs/in³ places it in a class with magnesium. In stiffness, it tops all other metals, including the steels, with a modulus of elasticity of 42 x 10⁶ psi. High specific heat and thermal conductivity make it a promising heat sink material. It also has a high melting point, 2,343F, high strength-to-weight ratio and a very good oxidation resistance.

Beryllium, however, is critically handicapped by a lack of ductility. As a result, the extensive research program under way on the metal has been and is aimed at improving its ductility and, alternately, at developing fabrication methods and structural forms which can utilize the metal with its present low ductility.

During the past year, Nuclear Metals, Inc., has been working on the fabrication of a simple beryllium structure under subcontract to The Martin Co. Original plans called for the fabrication of beryllium fins which Martin was going to use on five new rocket research vehicles it planned to design and fabricate. First, however, it was decided to build a simple wing box beam to learn more about fabricating the metal. Latest Air Force reports indicate that Martin is well pleased with results to date.

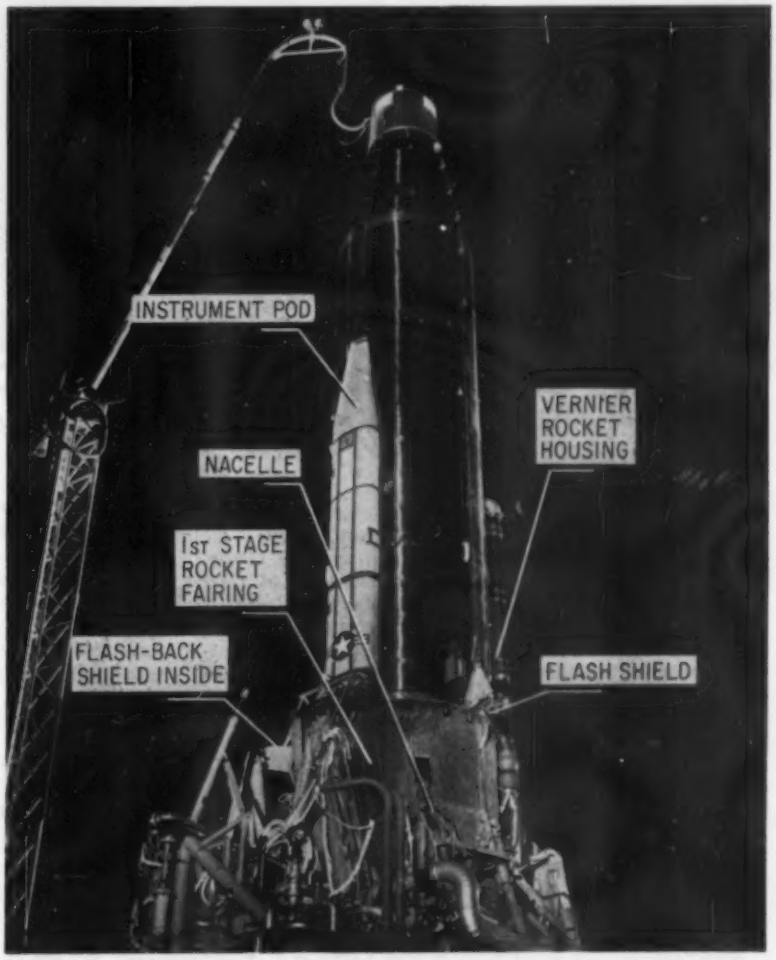
Nuclear Metals is also making trial beryllium sheets for Lockheed Aircraft Corp. At one time, Lockheed was reported to be very much interested in the development of a heat-sink beryllium nose cone for the Polaris missile. Allied to this application, of course, is the use of a beryllium heat shield on NASA's manned space capsule.

Nuclear Metals is working on the development of beryllium oxide ceramics for Navy Bureau of Aeronautics, on beryllium composite structures for the Air Force and on beryllium extrusions for Northrop.

USAF Beryllium Contract

Air Force has one contract with Brush Beryllium Co. on beryllium alloy development and another for the procurement of beryllium sheet. The second covers a study on sheet rolling as well. Progress on both contracts during the past year is reported to be satisfactory.

In the hope that beryllium will dis-



PLASTICS now are being used to fabricate components of many missiles, such as the Atlas ICBM. Improved high temperature resistance and strength properties have given plastics a high strength-to-weight ratio at elevated temperatures.

CASE HISTORIES

Two precision ball bearings, one concentric within the other, are periodically rotated in alternating directions during operation—thus reducing random drift to 0.25 degree per hour.

Photo: courtesy Sperry Gyroscope Co.

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SOLUTION:

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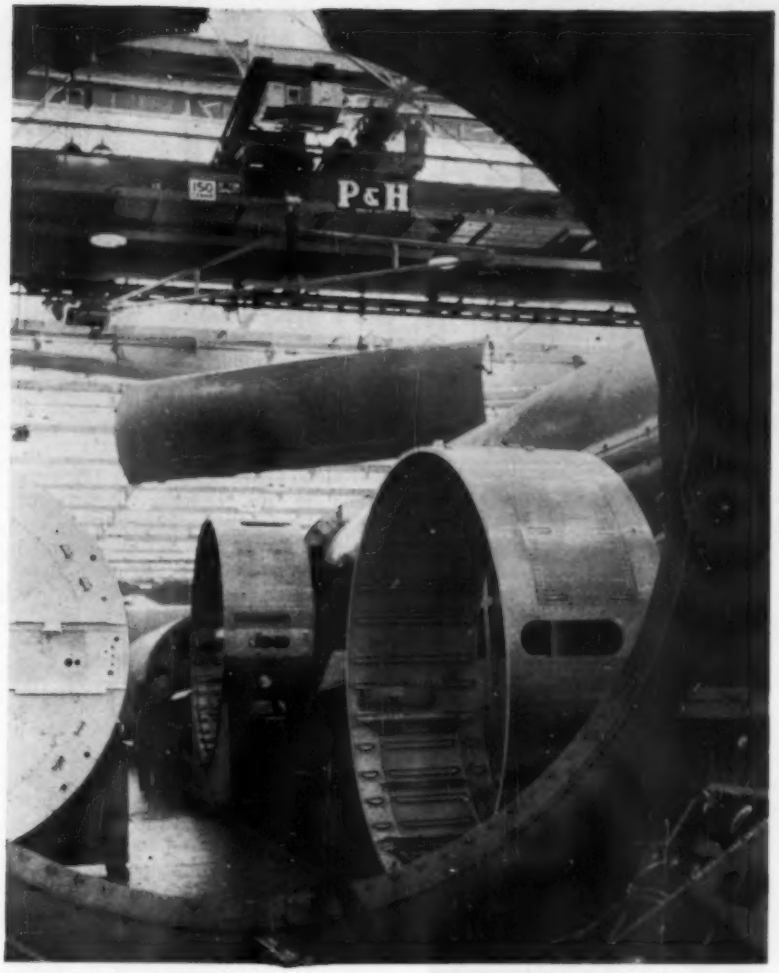

DOUGLAS THOR ASSEMBLY

play greater ductility in an extremely pure form, the Air Force gave Alloyd Research Corp. a contract to produce some ultra pure beryllium. This program has yet to get off the ground; even when it does, many metallurgists hold little hope for any significant improvement in ductility.

BuAer has had a beryllium wire program under way at Brush during the past year and recently began to purchase wire from the company. BuAer metallurgists see great promise in the wire as a reinforcing element in composite aircraft structural materials, a role somewhat akin to that of the glass fibers now being used with the aluminum matrix.

Choice Material

There is now a strong belief among many metallurgists, both in and out of the military, that even with its low ductility and other drawbacks such as high price and toxicity, beryllium will prove the choice structural material for many aircraft applications at all temperatures up to about 1200F. They see it being used for gyroscope components, aircraft brake disks, bolts, reentry vehicles—manned and unmanned—rocket fins, skin panels, aircraft trim tabs and aerodynamic fences, turbine compressor wheels, and satellite shells. Some uses are already established.

Titanium Progress

Titanium, while still not achieving the wonder status many once claimed for it, nevertheless made some significant advances during the past year in filling many aircraft structural applications and most of its more practical technical aspirations as an aircraft structural material suitable for use from a few hundred degrees to 1200F and, for short service times, to 1700F.

The past year, the Navy says, brought titanium practically to fruition, particularly in the Department of Defense sheet rolling program.

During the past year, the first all-beta titanium alloys were introduced. Still not commercial—only slightly more than

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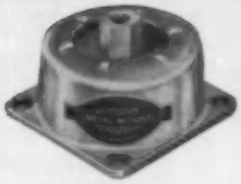

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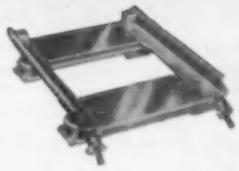

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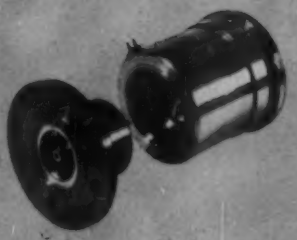

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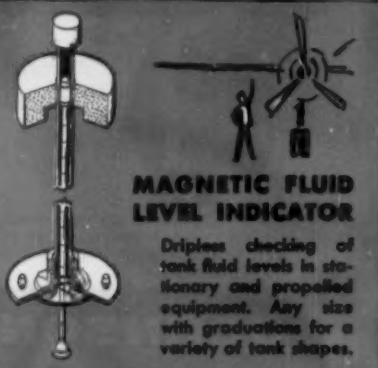

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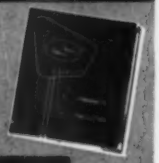

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11,000 lb. have been produced—the material shows great promise for aircraft structural applications. It is weldable, formable and has a high room temperature strength of approximately 280,000 psi. Titanium's high strength approaches that of steel while its low density places it in the aluminum weight class.

The all-beta alloy already appears to have staked a strong claim on solid propellant motor casing applications. As a result, the all-beta alloy seems to be a good bet for the Pershing casing and a strong possibility for the same job in the Minuteman and Polaris.

For liquid propellant rocket tankage, the strongly alpha titanium alloys are taking on added interest as a result of their excellent weldability. Two such alloys, Mallory Sharon's 821 and Titanium Metal Corp. of America's 811, were added to the Defense Department sheet rolling program last year.

First shipment of .003-in. titanium alloy foil last year by Titanium Metal demonstrated the growing effectiveness of continuous rolling techniques in turning out thin, wide sheets of the metal. An important consequence of the introduction of the thin sheets and foil has been the initiation of widespread work on titanium honeycomb structures by companies such as Convair-Forth Worth. So far there have been just samples and test panels, but there is a possibility that the honeycomb core material will find applications in the B-70 and F-108, along with new heat treatable titanium alloys.

Explosive Forming

Another noteworthy program of the past year has been Aerojet-General's evaluation of explosive forming of titanium. The technique itself, in which an explosive is used to propel the plunger or create the shock wave which forces the metal into the shaping die, has also made much progress during the past year. It shows considerable promise for forming titanium and other materials, some of which until now have been difficult or even impossible to shape by any other means. Other aviation companies such as Lockheed and Convair are also actively experimenting with explosive forming.

Steels and other ferrous alloys, among the oldest of construction materials, have recently displayed some interesting, heretofore hidden, potentialities to metallurgists which will keep them in contention for structural aeronautical applications at temperatures to at least 1200F.

Hot work die tool steels are currently generating a great deal of interest among BuAer and Air Research and Development Command metallurgists. Until recently, these compositions were considered too hard to work with as

structural materials. With the development of suitable modifications, metallurgists are now learning how to handle them and how to emphasize their structural advantages.

On a strength-to-weight basis, the hot-work die steels are reported to outperform stainless steels, typical titanium alloys and currently available beryllium at temperatures up to about 1,000F. Also, they show good ductility and low notch sensitivity.

Low notch sensitivity of the hot work steels is proving of prime interest to manufacturers of jet aircraft, both civil and military, as a promising answer to the problem of crack propagation. During the past year, BuAer has undertaken a cooperative project with Temescal Metallurgical Corp. and Vanadium Steel Corp. Vanadium will supply its Vasco Jet hot work die steel to Temescal which will melt the steel by electron beam (in itself a comparatively new and promising technique for processing purer metals and alloys). The material goes back to Vanadium for shaping and then to BuAer for evaluation of notch sensitivity and crack propagation properties.

The stainless steels are still important aircraft structural materials for temperatures, to about 1,200F as a result of their high strength and corrosion and oxidation resistance. During the past year, steel producers have devoted intense effort to improving the properties and processing of the stainless steels for the aircraft industry.

Progress in Steels

New mills have been put into operation for producing thin, flat, wide, high tolerance stainless sheets. Significant progress has been made in the fabrication of stainless honeycomb sections. Many existing stainless compositions have been modified to achieve important improvements in creep properties. And a lot of development work has gone into precipitation hardening to improve the already high strength of stainless steels.

An interesting sidelight on stainless progress involves the work of National Carbon Co. in the fabrication of large graphite electrodes. Until recently, small furnace size made it impossible to braze large sections of steel honeycomb. With the new electrodes, stainless sections 10x20 ft. are now possible. And it is expected that these large, brazed, stainless steel honeycomb panels will account for a major share of the B-70 and F-108 airframes.

Recent metallurgical advances have made it possible to develop ultra high strength steel with tensile strengths reportedly as high as 350,000 psi. At least one major steel producer is believed to have under development a steel with a tensile strength of 500,000

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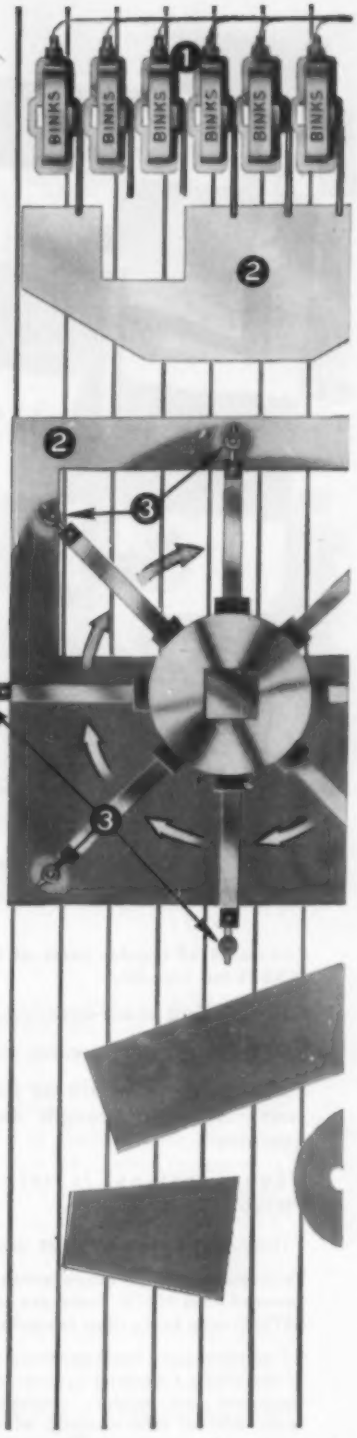

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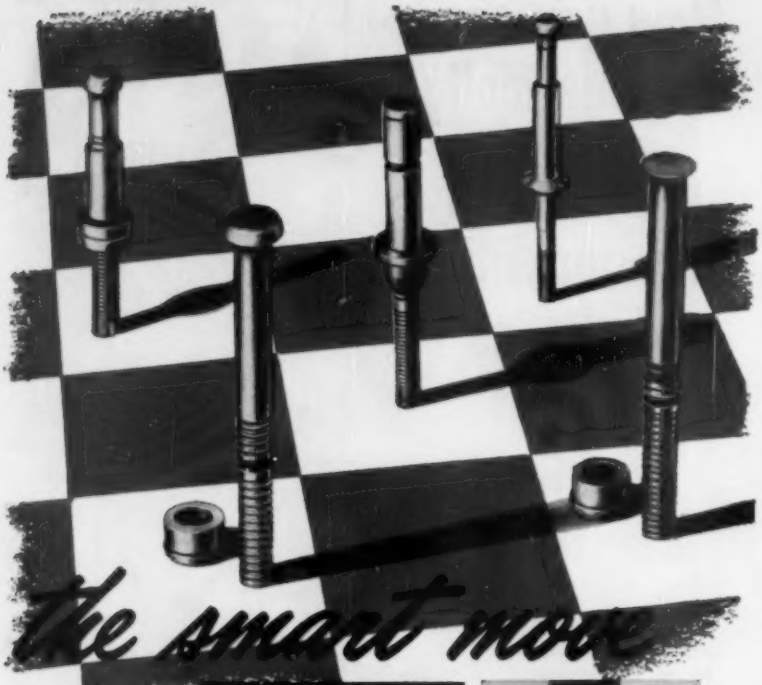

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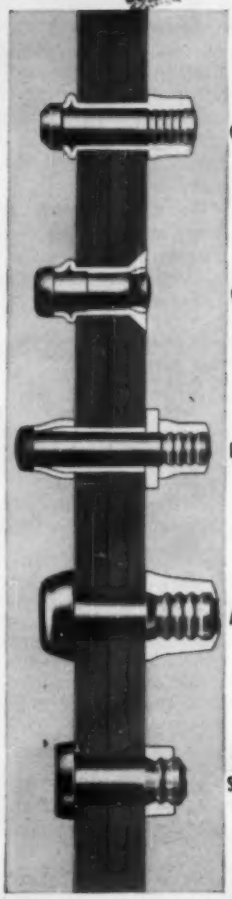

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psi. Provided it has suitable joining and welding characteristics, such a steel will be of major interest to the aircraft manufacturers for use at room temperatures or for shorter times at temperatures as high as 1000F.

Another important program is now under way in BuAer itself. It involves the development of structural materials containing little or no strategic elements such as nickel and chromium. An outgrowth of an earlier program on the Thermenal iron-aluminum compositions which showed excellent oxidation resistance at 2000F but poor ductility, the new compositions, in which 15-35% of the iron has been replaced by manganese, shows good ductility as well as oxidation resistance in air at 200-220F.

Navy Tests

The new alloys are still in the exploratory stage, says BuAer, with many tests still to be run. Among other things, BuAer is now experimenting with the addition of precipitation hardening elements, which usually entail sacrifices in oxidation resistance and ductility. Fortunately, one BuAer metallurgist points out, there is plenty to sacrifice. It is hoped that the new compositions will compare favorably with steels in the 1200-1500F category, in which case the low cost of the new iron alloys would give them a decided edge.

Another recent development of importance in the iron alloy area is an improved ferritic material used in bearings now offered by Clevite Corp. The new material is said to increase the service temperature of bearings from 900F to 1200F.

Progress of the super alloys—nickel, cobalt, and chrome base—has proven comparatively insignificant throughout the past year. Metallurgists have pushed the service temperature limit of the nickel base alloys up another 50 deg. to about 1750F and believe another 50-100 deg. may be possible.

For structural materials to serve at temperatures above 2000F, researchers have had to go to the refractory metals, most notably tungsten, tantalum, molybdenum and niobium. During the past year, the refractories have received a great deal of attention for application in such hot spots as the Air Force's 2500F leading edge program and in uncooled rocket nozzles and, as a result, have made impressive gains (AW Feb. 2, p. 50). Despite these recent advances, however, the refractory metals remain a comparatively unplumbed area and will undergo even greater development during the present and future years.

At the other end of the temperature spectrum, the —400F temperatures of

the liquefied gases, some interesting developments have been taking place in the selection of materials for pressure vessels and tankage. So far the choice materials for these jobs have been the high temperature austenitic stainless steels, aluminum alloys, and to a limited extent 6Al-4V titanium alloy. Now, however, the newer titanium alloys such as 6Al-4Zr-1V and 8Al-2Nb-1Ta are receiving serious consideration, owing to their low notch sensitivity and high impact resistance.

Along with the metals, the nonmetallic materials have made significant progress during the past year. Among the more notable achievements:

• **New lubricants** and hydraulic fluids have been developed and, in some cases, approved for high temperature service in aircraft and missiles (AW, Sept. 29, p. 51; Jan. 5, p. 71).

• **High density halocarbon** damping fluids helped in the miniaturization of inertial guidance systems while other halocarbon oils and waxes were developed for the lubrication and protection of missile components in highly reactive test environments (AW, Jan. 5, p. 94).

• **Graphite,** which comes into its own as a structural material at temperatures above 4500F, was wedded to a silicide and carbide coating which provided the material improved protection against oxidation and erosion.

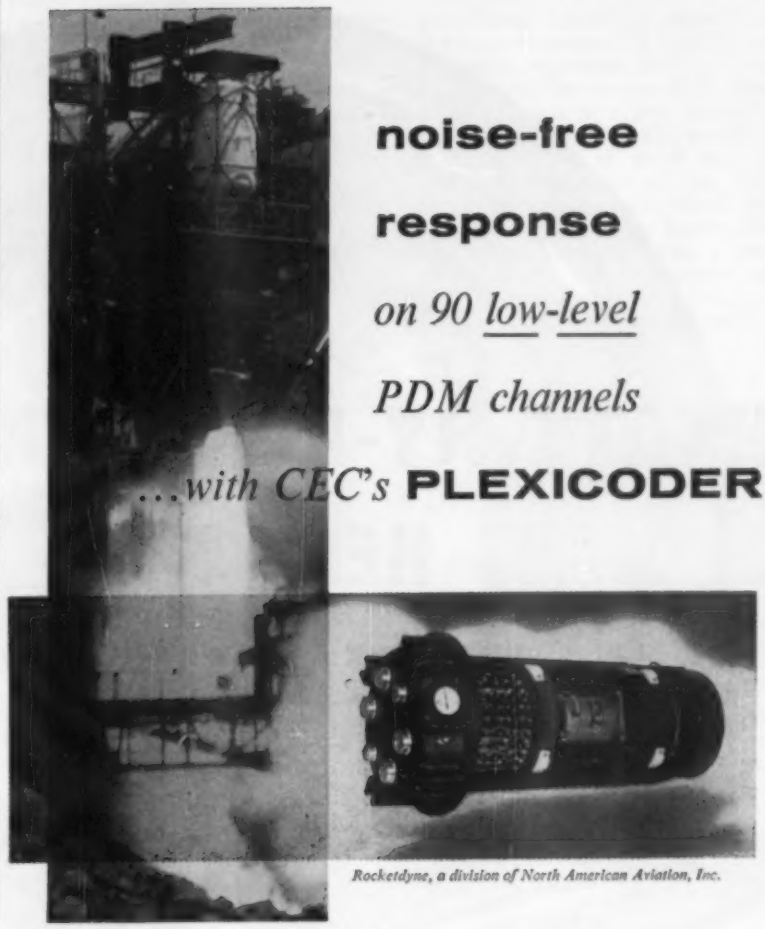
• **Work on whiskers**—fine filaments of metals and non-metals which exhibit near perfect strength properties—moved sharply ahead in 1958. One impressive achievement was National Carbon's work in growing carbon whiskers. Techniques for turning the filaments into useful structures, however, still appear to be far off.

• **Aluminized quartz fibers,** an Air Force sponsored program now under development, show promise as a high temperature composite material.

• **Use of quartz lamps** as the heat source for brazing titanium honeycomb, a recent outgrowth of an Air Force program with Armour Research Foundation, is proving cheaper, quicker and more versatile than former methods. More important, it has made it possible to braze larger honeycomb sections.

• **Research** has shown that single crystals of metal oxides display a fair degree of ductility. There is a good possibility that with continued effort this could lead to the commercial development of ductile ceramics.

• **Composite materials** last year again were subjected to a heavy development effort. Work on the familiar sandwich construction form was aimed principally at improving the structural adhesives and replacing the common aluminum core with honeycombs of higher temperature steels and titanium alloys. Other approaches, still to be proven,



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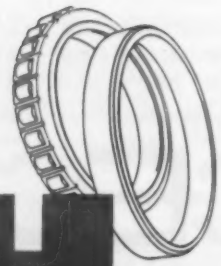

Another GM GENERAL MOTORS contribution to aviation progress

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involved bonding music wire with a tensile strength of 450,000 psi. into high tensity laminates with good damping characteristics and embedding strong but easily oxidized refractory wires and powders in oxidation resistant matrices.

• **Transparent materials** for cockpit or manned capsule enclosures, despite a large development effort, are still hard pressed to keep up with fast rising temperature requirements. The potential for present plastics ends at about 500F. Glass, despite its high weight and low impact resistance, appears to be the next step. Several enclosures are now being designed with various edge attachments that will permit equalized loading of glass in tension and thereby reduce weight. Other investigations are under way on double wall enclosures with cooling mechanisms between the walls and on transparent materials that can keep out harmful radiations.

• **Research on elastomers** succeeded in pushing their service temperature limit to about 600F and improving resistance to aviation fuel and rocket propellants, lubricants, hydraulic fluid, oxidation, radiation, etc. This in turn has led and will continue to lead to better sealants, flexible connectors, tires, gaskets, wire insulation, fuel bladders and the like. There is still a need for elastomeric materials capable of service at temperatures at 1000-1500F.

Plastics have been making rapid advances along all fronts. Starting out from their radome uses in World War II aircraft, reinforced plastics have moved into advanced aircraft and missile radomes, nose cones, bulkheads, wing and fin panels, control flaps, skins, rocket nozzles and blast tubes, pressure bottles, heat shields, and almost every other area of missiles, aircraft, satellites and space probes.

Plastic Uses

Notable improvements have been made in the past year in increasing the high temperature potential of many different plastics. New phenolic and silicone laminating resins are now capable of long duration service at 700-800F. For short periods, many plastics are capable of withstanding peak heating of 1000-1200F. The plastics industry itself has for its goal a short time service at 2000F.

With reinforcement or cooling, some of the newer plastics are said to be capable of maintaining their structural integrity at temperatures as high as 10,000-12,000F for brief periods. It is this characteristic along their fairly high heat absorption during phase changes that has made plastics attractive as ablation materials for nose cones and rocket nozzles. The problem now is to find ways of extending service times of these materials to periods even as long as 10 min.

Another interesting development in the plastics field involves a fabrication technique more than the material itself. Called filament winding, it consists of passing a reinforcement filament through a resin bath, winding it around a mandrel and then heat curing it. Aerojet-General has been working on this, using glass fibers in a phenolic binder to form a liquid propellant rocket nozzle inside of which is then placed a porous metal lining. Liquid fuel passes through the liner, vaporizes and cools the nozzle. More important, the high tensile strength and low density of the wound filaments result in a high strength-to-weight ratio that is hard to match.

With cooling or some other approach, existing materials can handle almost all of aviation's current high temperature assignments. Most of these approaches, however, entail a severe weight penalty, and the payload capability of present weapon systems and space vehicles is already very low.

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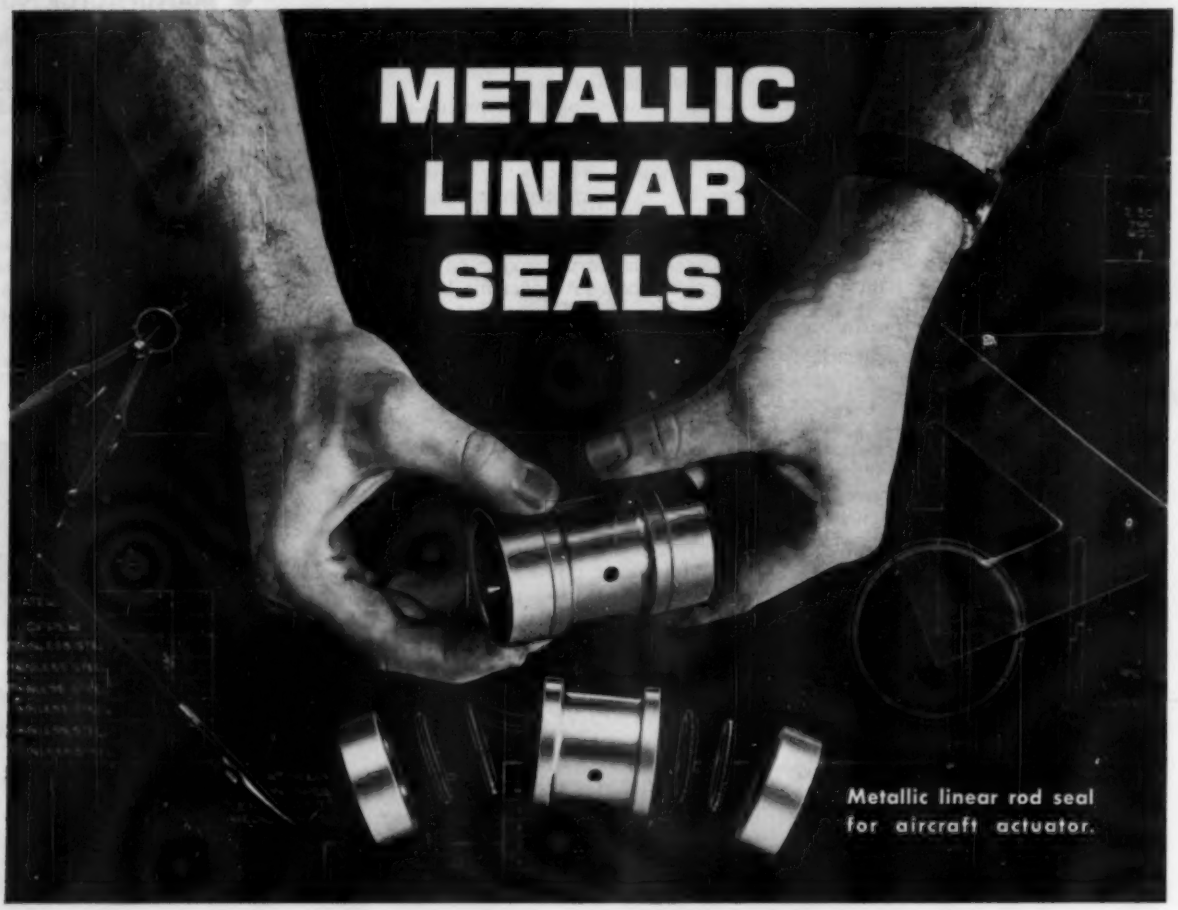

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U.S. Military Aircraft

Manufacturer	Military designation	Military name	Primary mission	Number in crew	Over-all span	Over-all length	Over-all height, 3-pt.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Maximum gross wt., lb.	Number, make, model and max. rating, ea.
BASIC AIRCRAFT DATA				**DIMENSIONS**					**WEIGHTS**			**POWERPLANT**
Beech Aircraft Corp. *Wichita, Kans.*	T-34A	Mentor	Trainer	2	32' 10"	25' 11"	9' 7"	178	2,246	2,950	.....	1 Con. O-470-13 @ 225 hp.
	.....	Jet Mentor	Trainer	2	32' 9"	30'	9' 9"	178	3,034	4,360	.....	1 Con. J69-T-9 @ 920 lb. t.
	L-23F	Twin-Bonanza	Liaison	5	.....	33' 2"	14' 2"	.....	5,000*	7,638	.....	2 Lyc. IGSO480-A1A6 @ 345
Boeing Airplane Co., *Seattle, Wash.*	B-47E	Stratojet	Med. Bomber	3	116'	107'	28'	.....	.....	.....	200,000	6 GE J47-GE-25 @ 6,000 lb.
	B-52A	Stratofortress	Heavy Bomber	6	185'	152' 9"	48' 3"	4,000	.....	350,000+	.....	8 P&W J57-P-1W @ 10,000+
	B-52B	Stratofortress	Heavy Bomber	6	154'	152' 9"	48' 3"	4,000	.....	350,000+	.....	8 P&W J57-P-1W @ 10,000+
	B-52C	Stratofortress	Heavy Bomber	6	185'	152' 9"	48' 3"	4,000	.....	400,000+	.....	8 P&W J57-P-19W @ 10,000+
	B-52D	Stratofortress	Heavy Bomber	6	185'	152' 9"	48' 3"	4,000	.....	400,000+	.....	8 P&W J57-P-19W @ 10,000+
	B-52E	Stratofortress	Heavy Bomber	6	185'	152' 9"	48' 3"	4,000	.....	400,000+	.....	8 P&W J57-P-19W @ 10,000+
	B-52F	Stratofortress	Heavy Bomber	6	185'	152' 9"	48' 3"	4,000	.....	400,000+	.....	8 P&W J57-P-43W @ 10,000+
	B-52G	Stratofortress	Heavy Bomber	6	185'	157' 9"	40' 9"	4,000	.....	430,000+	.....	8 P&W J57-P-43W @ 10,000+
	.....	Dyna-Soar[1]	Recon.-Bomber	..	.....	.....	.....	.....	.....	.....	.....	.....
Cessna Aircraft Co. *Wichita, Kans.*	T-37A	.....	Trainer	2	33' 10"	29' 3"	9' 2"	183.9	3,945	6,547	.....	2 Con. J69-T-9 @ 920 lb.t.
Chance Vought Aircraft, Inc. *Dallas, Tex.*	F8U-1	Crusader I	Day Fighter	1	35' 8"	54' 3"	15' 9"	.....	.....	.....	.....	1 P&W J57-P-4A @ 10,000+
	F8U-1P	Crusader I	Photo-Recon.	1	35' 8"	54' 3"	15' 9"	.....	.....	.....	.....	1 P&W J57-P-4A @ 10,000+
	F8U-2	Crusader II	Day Fighter	1	35' 8"	54' 3"	15' 9"	.....	.....	.....	.....	1 P&W J57-P-16 @ 10,000+
	F8U-2N	Crusader II	Ltd. AW Fighter	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J57-P-20 @ 10,000+
Convair Division General Dynamics Corp. *San Diego, Calif.*	F-102A	Delta Dagger	AW Interceptor	1	38' 1"	68' 3"	21' 2"	.....	.....	.....	.....	1 P&W J57-P-23 @ 10,000+
	TF-102A	.....	Trainer	2	38' 1"	80' 2"	20' 7"	.....	.....	.....	.....	1 P&W J57-P-23 @ 10,000 +
	F-106A	Delta Dart	AW Interceptor	1	38' 3"	70' 9"	20' 3"	.....	.....	.....	.....	1 P&W J75 @ 15,000+ lb. t.
Ft. Worth (Tex.) Division	T-29C	Flying Classroom	Crew Trainer	4	91' 9"	74' 8"	27' 3"	817	29,000	43,575	43,575	2 P&W R-2800-99W @ 2,500
	B-58	Hustler	Bomber	3	57'	97'	31'	.....	.....	160,000	.....	4 GE J79 @ 15,000 lb.t.
	WS-125A	.....	Bomber	..	.....	.....	.....	.....	.....	.....	.....	Nuclear power (P&W)
Douglas Aircraft Co., Inc. *Long Beach, Calif.*	B-66B	Destroyer	Tac. Bomber	3	72' 6"	75' 2"	23' 7"	780	42,086	78,000	83,000	2 All. J71-A-11 @ 10,000 lb.t.
	WB-66D	Destroyer	Weather-Recon.	3	72' 6"	75' 2"	23' 7"	780	43,476	70,000	83,000	2 All. J71-A-13 @ 10,200 lb.t.
El Segundo (Calif.) Division	A3D-2	Skywarrior	Attack	3	72' 6"	73' 6"	22' 9"	780	.....	70,000	.....	2 P&W J57-P-10 @ 10,000+
	A4D-2	Skyhawk	Attack	1	27' 6"	39' 6"	15' 2"	260	8,300	15,000	.....	1 Wr. J65-W-4 @ 7,200 lb.t.
	F4D-1	Skyray	Interceptor	1	33' 6"	44' 4"	13'	557	.....	25,000	.....	1 P&W J57-P-12 @ 10,000 lb.
Grumman Aircraft Eng'rg. Corp. *Bethpage, N. Y.*	F9F-8T	Cougar	Trainer	2	34' 6"	48' 6"	13' 1"	.....	.....	20,600	.....	1 P&W J48-P-8A @ 7,200 lb.t
	F11F-1	Tiger	Interceptor	1	31' 8"	46' 10"	12' 9"	.....	.....	.....	.....	1 Wr. J65-W-18 @ 10,500 lb.t
	F11F-1F	Super Tiger	Interceptor	1	31' 8"	46' 10"	12' 9"	.....	.....	.....	.....	1 GE YJ79-GE-3 @ 10,000+
	S2F-1	Tracker	ASW	4	69' 8"	42' 3"	16' 3"	.....	.....	.....	.....	2 Wr. R1820-82 @ 1,525 hp.
	WF-2	Tracer	AEW	4	69' 8"	.....	.....	807	.....	.....	.....	2 Wr. R1820 @ 1,525 hp.
	W2F-1	.....	AEW	5	.....	.....	.....	.....	.....	.....	.....	2 All. turboprop
	AO-1AF	Mohawk	Observation	2	42'	41'	12' 8"	330	7,772	.....	12,800	2 Lyc. T53-L-3 @ 1,005 eshp.
	A2F-1	.....	Attack	2	.....	.....	.....	.....	.....	.....	.....	2 P&W J52 @ 7,500 lb.t.
Lockheed Aircraft Corp. *Burbank, Calif.*	F-104A	Starfighter	Interceptor	1	21' 11"	54' 9"	13' 6"	.....	.....	.....	.....	1 GE J79-GE-3A @ 15,000 lb.
	F-104B	Starfighter	Tac. Trainer	2	21' 11"	54' 9"	13' 6"	.....	.....	.....	.....	1 GE J79-GE-3A @ 15,000 lb
	F-104C	Starfighter	Fighter	1	21' 11"	54' 9"	13' 6"	.....	.....	.....	.....	1 GE J79-GE-7 @ 15,000 lb.t.
	F-104D	Starfighter	Tac. Trainer	2	21 '11"	54' 9"	13 '6"	.....	.....	.....	.....	1 GE J79-GE-7 @ 15,000 lb.t.
	EC-121D	Warning Star	Radar Picket	31	123' 8"	116' 2"	27'	1,654	.....	.....	.....	4 Wr. R 3350 @ 3,250 hp.
	T-33A	.....	Trainer	2	38' 11"	37' 8"	27'	238	8,400	11,700	15,001	1 All. J33-A-24 @ 6,100 lb.t.
	P2V-7	Neptune	ASW	..	103'	84' 9"	13 '6"	1,000	47,450	75,500	.....	2 Wr. R3350-32W @ 3,500 hp.
												2 We. J34 @ 3,400 lb.t.
	XP3V-1	.....	ASW	10	99'	104' 7"	33' 1"	1,300	.....	123,000*	.....	4 All. T56-A-10W @ 4,500 esh
	U-2	.....	Research	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J57 @ 10,000 lb.t.
Marietta (Ga.) Division	WS-125A	.....	Bomber	..	.....	.....	.....	.....	.....	.....	.....	Nuclear power (GE)
The Martin Co. *Baltimore, Md.*	.....	Dyna-Soar[1]	Recon.-Bomber	..	.....	.....	.....	.....	.....	.....	.....	Multi-rockets
	P5M-2	Marlin	ASW	8	118' 2"	101'	32' 8"	1,406	49,480	74,442	85,000	.2 Wr. R3350-32W @ 3,400 hp.
	YP6M-1	SeaMaster	Mine-Layer	4	100'	134'	31'	1,900	.....	.....	160,000	4 All. J71 @ 10,000 lb.t.
	P6M-2	SeaMaster	Mine-Layer	4	100'	134'	31'	1,900	.....	.....	160,000	4 P&W J75 @ 15,000+ lb.t.
McDonnell Aircraft Corp. *St. Louis, Mo.*	F-101C	Voodoo	Fighter-Bomber	1	40'	67' 5"	18'	.....	.....	.....	.....	2 P&W J57-P-13 @ 10,000+ l
	RF-101C	Voodoo	Photo-Recon.	1	40'	69' 3"	18'	.....	.....	.....	.....	2 P&W J57-P-13 @ 10,000+ l
	F-101B	Voodoo	Interceptor	2	40'	.....	18'	.....	.....	.....	.....	2 P&W J57-P-55 @ 10,000+ l
	F3H-2N	Demon		..	.....	.....	.....	.....	.....	.....	.....	.....
	F4H-1	.....	AW Interceptor	2	38' 5"	50'	.....	.....	.....	.....	40,000*	2 GE J79-GE-2 @ 15,000+ lb.
North American Aviation, Inc. *Los Angeles, Calif.*	B-70	Valkyrie	Bomber	4	.....	.....	.....	.....	.....	.....	600,000*	6 GE YJ93 @ 25,000+ lb.t.
	F-86F	Sabre	Fighter-Bomber	1	37' 1"	37' 5"	14' 7"	.....	.....	.....	17,000	1 GE J47-GE-27 @ 5,970 lb.t.
	F-86H	Sabre	Fighter-Bomber	1	37' 1"	38' 8"	15'	.....	.....	.....	.....	1 GE J73-GE-3 @ 9,000 lb.t.
	F-86K	Sabre	Interceptor	1	37' 1"	42' 4"	15'	.....	.....	18,500	20,347	1 GE J47-GE-33 @ 5,600 lb.t.
	F-86L	Sabre	Interceptor	1	37' 1"	42' 4"	15'	.....	.....	.....	.....	1 GE J47-GE-33 @ 7,650+ lb.
	F-100C	Super Sabre	Fighter	1	38'	47'	15'	.....	.....	.....	.....	1 P&W J57-P-7 @ 10,000+ lb.
	F-100D	Super Sabre	Fighter-Bomber	1	38'	47'	16'	.....	.....	.....	.....	1 P&W J57-P-21 @ 10,000 lb.t
	F-100F	Super Sabre	Fighter-Bomber	2	39'	60'	16'	385.2	21,346	34,235	.....	1 P&W J57 @ 10,000+ lb.t.
	F-107A	.....	Research	1	36' 7"	60' 10"	19' 8"	.....	.....	.....	.....	1 P&W J75 @ 15,000+ lbs.
	YF-108	.....	Interceptor	2	58'*	80'*	22'*	.....	.....	.....	100,000	2 GE YJ93 @ 25,000+ lb.t.
	X-15	.....	Research	1	22'	50'	13'	200	.....	.....	31,275	1 RMI XLR-99 @ 50,000+ lb.
Columbus (Ohio) Division	T-39	Saberliner	Utility	3	44' 5"	43' 8"	15' 11"	342.5	9,199	15,330	.....	2 P&W J60 @ 3,000 lb.t.
	FJ-4B	Fury	Fighter-Bomber	1	39' 1"	39' 6"	13' 11"	338	.....	19,900	.....	1 Wr. J65-W-16A @ 7,700 lb.t.
	XA3J-1	Vigilante	AW Attack	2	50'	70'	20'	.....	.....	.....	.....	2 GE J79-GE-2 @ 15,000 lb.t.
	T2J-1	.....	Trainer	2	38'	38' 8"	14' 9"	255	6,893	9,916	11,373	1 We. J34-WE-46 @ 3,400 lb.t.
Northrop Corp. *Hawthorne, Calif.*	T-38	Talon	Trainer	2	23' 3"	43'	11' 11"	.....	7,000	.....	10,960	2 GE J85 @ 2,500 lb.t.
	N-156F	.....	Fighter	1	.....	.....	.....	.....	.....	.....	13,000	2 GE J85 @ 2,500 lb.t.
Republic Aviation Corp. *Farmingdale, N. Y.*	F-105B	Thunderchief	Fighter-Bomber	1	34' 11"	63' 11"	19' 8"	.....	.....	.....	.....	1 P&W J75-P-5 @ 15,000+ lb.
Temco Aircraft Corp. *Dallas, Tex.*	TT-1	Pinto	Trainer	2	29' 10"	30'	10' 10"	180	3,139	4,400	4,400	1 Con. J69-T-2 @ 920 lb.t.

[1] Boeing is one prime contractor on a Phase I development contract awarded by USAF—Martin is the other (see below). Boeing associates include: General Electric, Rame-Wooldridge, North American Aviation Autonetics and Missile Development Divisions, Chance Vought Aircraft, Aerojet-General, Goodyear Aircraft Corp. and RCA.

ERPLANT		PERFORMANCE					ARMAMENT	CHRONOLOGY				Remarks
ks, model ating, es.	Normal fuel cap., gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Stall speed, dirty, mph.	Service ceiling, ft.	Combat radius, mi.	Number, type and designation	First flight of prototype	First production contract	First deliveries to service	First flight, first production article	
@ 225 hp.	50	187	1,120	55	18,200	.....	2 x .30 cal. mg.; 6 rockets	Dec. '48	.....	Aug. '50	Oct. '53	Navy version is T-34B.
920 lb. t.	180	288	1,440	69	25,000	.....	.....	Dec. '55	.....	.....	.....	Private venture; jet T-34.
A1A6 @ 345 hp.	.....	.....	.....	.....	.....	.....	None	.....	.....	.....	.....	New, bigger fuselage.
@ 6,000 lb. t.	.....	600+	.....	...	40,000+	1,500+	2 x 20 mm. cannon; 20,000 lb. bombs; GAM-63 Rascal.	Dec. '47	Sept. '48	Oct. '51	June '50	Production discontinued Feb. '57.
@ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	Apr. '52	Feb. '51	June '54	Aug. '54	XB-52 contracted June '46.
@ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Dec. '52	Nov. '55	Jan. '55	Also J57-P-29W; J57-P-19W.
@ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Dec. '53	Jan. '56	Mar. '56	Also J57-P-29W.
@ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Dec. '54	Nov. '56	Sept. '56	Also J57-P-29W.
@ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	May '53	Oct. '57	Oct. '57	Also J57-P-29W.
@ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Aug. '56	June '58	June '58	
@ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	2 NAA GAM-77 Hound Dog	.....	Sept. '57	Oct. '58	Oct. '58	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	USAF-NASA joint project.
920 lb.t.	321	401	2,500	82	36,400	800[2]	.....	Oct. '54	July '54	Sept. '55	Sept.'55	Side-by-side seats.
@ 10,000+ lb.t.	.....	1,100	.....	...	.....	.....	4 x 20 mm. cannon; 32 x 2.75-in. rockets.	Mar. '55	June '53	Mar. '57	Sept. '55	Plus 2-4 Sidewinders.
@ 10,000+ lb.t.	.....	1,100	.....	...	.....	.....	.....	Dec. '56	.....	Nov. '57	Dec. '56	
@ 10,000+ lb.t.	.....	M<2	.....	...	.....	.....	4 x 20 mm. cannon; 32 x 2.75-in. rockets.	Dec. '57	Dec. '57	.....	Aug. '58	Plus 2-4 Sidewinders.
@ 10,000+ lb.t.	.....	M<2	.....	...	.....	.....	.....	.....	.....	.....	.....	2-4 Sidewinders.
@ 10,000+ lb.t.	.....	M1+	.....	...	50,000+	.....	GAR-98 Falcons; 24 x 2.75-in. rockets	Oct. '53	.....	.....	.....	
@ 10,000 +lb.t.	.....	M1+	.....	...	50,000+	.....	.....	Oct. '55	Apr. '54	Nov. '55	Oct. '55	Side-by-side seats.
,000+ lb. t.	.....	M2	.....	...	60,000+	.....	MB-1 Genie.	Dec. '56	.....	.....	.....	F-106B is tandem two-seater.
W @ 2,500 hp.	1,550	300	1,370	92	24,000	.....	None	Sept. '49	.....	.....	.....	
0 lb.t.	.....	M2+	.....	...	50,000+	.....	Varied loads in external pods	Nov. '56	.....	.....	.....	Delta wing.
&W)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
10,000 lb.t.	4,650	600+	.....	...	.....	.....	2 x 20-mm cannon	June '54	Aug. '53	June '55	Jan. '55	
10,200 lb.t.	4,480	600+	.....	...	.....	.....	2 x 20-mm cannon	June '54	May '53	Apr. '55	Mar. '55	
@ 10,000+ lb.t.	.....	600+	.....	...	.....	.....	2 x 20-mm cannon	.....	.....	.....	.....	Also photo, ECM version.
7,200 lb.t.	770	650+	.....	...	.....	.....	2 x 20-mm cannon	.....	.....	.....	.....	Also A4D-2N night fighter.
@ 10,000 lb.t.	.....	700+	.....	...	.....	.....	.....	.....	.....	.....	.....	
@ 7,200 lb.t.	.....	650+	.....	...	.....	.....	2 x 20 mm cannon	.....	.....	.....	.....	
10,500 lb.t.	.....	M1+	.....	...	.....	.....	4 x 20 mm cannon	.....	.....	.....	.....	First U. S. area-ruled fighter.
@ 10,000+ lb.t.	.....	1000+	.....	...	55,000	.....	4 x 20 mm cannon	.....	.....	.....	.....	
1,525 hp.	.....	.....	.....	.....	.....	.....	Sonobuoy, depth charges, missiles	Dec. '53	.....	.....	.....	S2F-3
,525 hp.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Large overhead radome.
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Overhead radome.
1,005 eshp.	.....	316	3,000	...	25,000	200	.....	.....	.....	.....	.....	STOL capability.
00 lb.t.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Missile platform.
@ 15,000 lb.t.	.....	M2+	.....	...	70,000+	.....	1 x T-171 Vulcan; 2 x Sidewinders	Mar. '54	June '54	Feb. '58	Feb. '56	Speed record, 1,404 mph.; altitude, 91,243 ft.
@ 15,000 lb.t.	.....	M2+	.....	...	70,000+	.....	2 x Sidewinders	.....	.....	Oct.' 58	.....	
15,000 lb.t.	.....	M2+	.....	...	70,000+	.....	1 x T-171Vulcan; 2 x Sidewinders	.....	.....	.....	.....	
15,000 lb.t.	.....	M2+	.....	...	70,000+	.....	1 x T-171 Vulcan	.....	.....	Dec. '53	.....	WV-2E is Navy version.
3,250 hp.	.....	300*	.....	.....	.....	.....	None	Mar. '49	Oct. '47	Aug. '48	Sept. '49	TV-2 is Navy version.
6,100 lb.t.	760	600	6,330	97	40,000	480	2 x .50-cal mg	May '45	.....	Apr. '54	.....	Electra re-design.
@ 3,500 hp. &	.....	.....	.....	.....	22,000	.....	6 x 20 mm cannon	.....	.....	.....	.....	
0 lb.t.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Weather recon.
@ 4,500 eshp.	.....	450+	.....	.....	.....	.....	.....	.....	.....	.....	.....	
,000 lb.t.	.....	.....	.....	.....	55,000+	.....	.....	.....	.....	.....	.....	Studies include low-level subsonic jet.
E)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	USAF-NASA joint project.
@ 3,400 hp.	2,815	250	1,200	90	24,000	700	2 x 20 mm cannon; 8 rockets	Aug. '53	May '52	June '54	Apr. '54	Navy follow-on award Sept. '57.
00 lb.t.	.....	600+	.....	...	40,000+	1,500	.....	July '55	.....	.....	.....	Six built, production complete.
,000+ lb.t.	.....	600+	.....	...	40,000+	1,500	.....	.....	Aug. '56	.....	.....	
@ 10,000+ lb.t.	.....	1,200+	.....	...	55,000+	.....	4 x 20-mm cannon	Sept. '54	Sept.'52	.....	Sept. '54	Production completed.
@ 10,000+ lb.t.	.....	1,000+	.....	...	.....	.....	None	.....	.....	.....	.....	Production completed.
@ 10,000+ lb.t.	.....	1,000+	.....	...	.....	.....	GAR-98 Falcons; 2 MB-1 Genie	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Production phase-out in '59.
15,000+ lb.t.	.....	M2+	.....	...	.....	1,000	4 Sparrow III, plus Sidewinders	May '58	.....	.....	.....	BLC from No. 6 onwards.
,000+ lb.t.	.....	2,000+	.....	...	70,000+	7,000+	.....	.....	.....	.....	.....	Comparable in size to B-52.
@ 5,970 lb.t.	.....	650+	.....	...	45,000+	500+	6 x .50 cal. mg; 16 x 5-in. HVAR	Apr. '53	Dec. '57	.....	Sept. '53	Or 6 x .50 cal. mg.
9,000 lb.t.	.....	700	.....	...	45,000+	1,150	4 x 20 mm cannon	July '54	.....	.....	.....	For NATO.
@ 5,600 lb.t.	.....	650+	.....	...	45,000+	500+	4 x 20 mm cannon	.....	.....	.....	.....	Many F-86D conversions.
@ 7,650+ lb.t.	.....	650+	.....	...	45,000+	.....	.....	May '53	Mid-'53	Sept. '54	.....	
10,000+ lb.t.	.....	1,000+	.....	...	50,000+	500+	4 x 20 mm cannon	Jan. '56	.....	Mid-'56	.....	
@ 10,000 lb.t.	.....	1,000+	.....	...	50,000+	500+	4 x 20 mm cannon	Aug. '56	May '56	May '57	Mar. '57	Also Fighter-Trainer.
,000+ lb.t.	1,185	1,000+	20,000	...	50,000+	1,000+	2 20 mm cannon	Sept. '56	.....	.....	.....	To NASA for high-speed research.
,000+ lbst.	.....	1,300+	.....	.....	.....	.....	.....	.....	.....	.....	.....	Design similar to B-70.
000+ lb.t.	.....	M3	.....	...	70,000+	1,100*	3 GAR-9 Falcons	.....	.....	.....	.....	Interim: 2 RM1 XLR-11-5
@ 50,000+ lb.t.	.....	2,000	.....	...	70,000+	.....	None	Sept. '58	Oct. '58	.....	.....	Or GE J85.
000 lb.t.	850	575	5,550	87	40,000+	1,400	None	Jan. '57	.....	.....	.....	
@ 7,700 lb.t.	.....	667	7,500	115	40,000+	.....	4 x 20 mm cannon; Sidewinders	.....	.....	.....	Aug. '58	Boundary layer control.
15,000 lb.t.	.....	M2	.....	.....	.....	.....	.....	Jan. '58	Sept. '56	.....	Jan. '58	Ground-level ejection seats.
@ 3,400 lb.t.	381	492	5,000	79	40,000+	.....	2 x .50 cal. mg.; 14 2.75-in. rockets	.....	.....	.....	.....	
lb.t.	.....	850	.....	...	48,000	.....	.....	.....	Dec. '58	.....	.....	
lb.t.	.....	.....	.....	.....	.....	750	Sidewinder, Sparrow, Falcon	.....	.....	.....	.....	Low-cost NATO operation.
15,000+ lb.t.	.....	M1+	.....	...	50,000+	.....	1 x Vulcan 20-mm cannon	Oct. '55	.....	May '58	Apr. '58	Also F-105D and F-105E.
920 lb.t.	124	325	1,900	73	30,000	276	None	Mar. '56	June '56	Nov. '57	Nov. '57	Tandem seats.

Aviation
ivisions,
oodyear

[2] Range in statute miles.
[3] Martin is prime contractor on other Dyna-Soar Phase I development contract. Its associates include: Bell Aircraft Corp., Minneapolis-Honeywell, American Machinery & Foundry and Goodyear Aircraft Corp

U.S. Missiles

Category	GENERAL				STATUS				AIRFRAME					
	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Over-all length, less booster, ft.	Over-all span, wings or fins, ft.	Body diameter, ft.	Launching wt., less booster, lb.	
Air-to-Air	Eagle	XAAM-N-10	Navy	Bendix	✓	✓	..	..	Grumman	....	....	....	.....	
	Falcon	GAR-1, 2, 3, 4, 9	USAF	Hughes	..	..	✓	✓	Hughes	6.5	1.8	0.5	100	
	Genie	MB-1	USAF	Douglas	..	..	✓	✓	Douglas	8	....	....	.....	
	Sidewinder 1A	AAM-N-7	BuOrd	Philco/GE	..	..	✓	✓	.....	9	....	0.4	155	
	Sidewinder 1C	.....	BuOrd	.....	..	✓	..	..	.....	....	....	....	.....	
	Sparrow I	AAM-N-2	BuAer	Sperry	..	..	..	✓	Sperry	12	....	....	300	
	Sparrow III	AAM-N-6	BuAer	Raytheon	..	✓	✓	✓	Raytheon	12	3.3	0.8	350	
Air-to-Surface	Bold Orion	WS-199	USAF	.....	✓	..	..	..	.....	....	....	....	.....	
	Bullpup	ASM-N-7	Navy	Martin	..	..	✓	..	Martin	11	3	1	600	
	Corvus	XASM-N-8	Navy	Temco	..	✓	..	..	Tempco	....	....	....	.....	
	Crossbow	.....	.....	Northrop	..	✓	..	..	.....	....	....	....	.....	
	Gimlet	.....	Navy	.....	✓	✓	..	..	.....	....	....	....	.....	
	Hound Dog	GAM-77	USAF	NAA	..	..	✓	..	NAA	40	....	....	.....	
	Quail	GAM-72	USAF	McDonnell	..	..	✓	..	McDonnell	10	7	1.5	1,100	
	Rascal	GAM-63	USAF	Bell Aircraft	..	..	..	✓	Bell Aircraft	32	....	4	.....	
	Wagtail	.....	USAF	Minn.-Honeywell	..	..	..	..	.....	....	....	....	.....	
	Zuni	.....	BuOrd	.....	..	..	✓	..	.....	9	....	0.4	107	
Anti-Submarine	Able	.....	Navy	Avco	..	..	✓	✓	.....	....	....	1	500	
	Asroc	.....	BuOrd	Minn.-Honeywell	..	..	✓	..	.....	....	....	....	.....	
	Subroc	.....	BuOrd	Goodyear	✓	✓	..	..	Goodyear	....	....	....	.....	
Surface-to-Air	Bomarc	IM-99A	USAF	Boeing	..	..	✓	..	Boeing	47	18	3	15,000	
	Hawk	XM3	ArmyOrd	Raytheon	..	✓	✓	..	Nortronics/Raytheon	16	4	1.2	1,250	
	Mauler	.....	ArmyOrd	.....	✓	..	..	..	.....	....	....	....	.....	
	Nike Ajax	.....	Army Ord	Western Electric	..	..	..	✓	Douglas	21	....	1	.....	
	Nike Hercules	XM6E3	ArmyOrd	Western Electric	..	..	✓	✓	Douglas	27	....	2.5	.....	
	Nike Zeus	.....	ArmyOrd	Western Electric	..	✓	..	..	Douglas	....	....	....	.....	
	Redeye	.....	ArmyOrd	Chance Vought	✓	..	..	..	.....	....	....	....	.....	
	Talos	SAM-N-6	BuOrd	Bendix	..	..	✓	..	McDonnell	20	....	2.5	3,000	
	Tartar	.....	BuOrd	Convair/APL	..	✓	✓	..	Convair	....	....	....	.....	
	Terrier	SAM-N-7	BuOrd	Convair	..	..	✓	✓	Convair	15	....	....	3,000[1]	

Abbreviations:
AGL — Allegany Ballistics Labs
ABMA — Army Ballistic Missile Agency
AC — AC Spark Plug
ADC — Aerophysics Development Corp.
APL — Applied Physics Laboratory
Army Ord — Army Ordnance
BuAer — Bureau of Aeronautics
BuOrd — Bureau of Ordnance
FTL — Federal Telecommunications Laboratory
GE — General Electric
GFE — Government furnished equipment
Gr.Central — Grand Central Rocket Co.
ICBM — Intercontinental ballistic missile

Launching wt., less booster, lb.	POWERPLANT				GUIDANCE		PERFORMANCE		REMARKS
	Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum Mach number	Maximum range, n. mi.	
.....	.....	1	.....	.....	Bendix	active radar homing	.....	30+	Long range missile for subsonic aircraft platforms will have nuclear warhead.
100	Thiokol	1	spr.	.....	Hughes	Semi-active homing/infrared	.....	.....	GAR-3 and -4 are advanced versions of GAR-1 and -2; 1 and 3 use radar; 2 and 4, infrared. GAR-9, scheduled for F-108, will have longer range and nuclear capability.
.....	Aerojet-General	1	spr.	.....	.....	Unguided	.....	1.5	Nuclear warhead; guided version under development.
155	Naval Powder Factory	1	spr.	.....	Philco/GE	Infrared	.....	2	Developed by NOTS; GAR-8 is USAF version.
.....	.....	..	.....	.....	Philco	Infrared	.....	.....	Advanced Sidewinder under development at NOTS; greater speed and range; formerly called Diamondback.
300	Aerojet-General	1	spr.	.....	Sperry	Beam rider	2+	5+	Being replaced by Sparrow III.
350	Aerojet-General	1	spr.	.....	Raytheon	Semi-active radar homing	2+	.....	All-weather, all aspect capability; carried in 2's or 4's.
.....	.....	..	spr.	.....	.....	.....	.....	.....	Air-launched IRBM.
600	Aerojet-General	1	spr.	.....	Martin	Command	1.8	.....	Close tactical support; later models may use prepackaged lpr. engine; White Lance is USAF version.
.....	RMD	..	lpr.	.....	Texas Instr./W. L. Maxon	Homes on enemy radar	.....	.....	Stand-off missile for carrier aircraft.
.....	.....	..	.....	.....	.....	Homes on enemy radar	.....	.....	
.....	.....	..	.....	.....	.....	Unguided	.....	.....	
.....	P&W	1	J52 tj.	7,500	Autonetics	Inertial	.....	.....	For B-52G.
1,100	GE	1	J85 tj.	2,500	.....	.....	0.9	200	Also Green Quail; diversionary missile for B-47, B-52.
.....	Bell Aircraft	3	lpr.	12,000	Bell Aircraft	Radar-command	1.5	100	For B-47.
.....	.....	..	.....	.....	Minn.-Honeywell	Inertial	.....	.....	
107	.....	1	spr.	.....	.....	Unguided	3	.....	Five inch folding fin rocket developed by NOTS to replace WW II HVAR; also air-to-air.
500	.....	..	.....	.....	.....	.....	.....	.....	Fired from gun launchers on destroyer escorts and frigates.
.....	.....	..	.....	.....	.....	.....	.....	.....	Developed by NOTS.
.....	Thiokol	..	spr.	.....	Kearfott/Librascope	.....	.....	.....	Fired through torpedo tubes; developed by Naval Ordnance Laboratory.
15,000	Marquardt	2	RJ43-MA-3rj.	10,000	Westinghouse	SAGE/active radar homing	2.5	200	Super Bomarc, IM-99B, will have 400-mi. range, Mach 3.5 capability, spr. instead of lpr. booster.
1,250	Aerojet-General	1	XM22E5 spr.	.....	Raytheon	Semi-active radar homing	.....	22	Low altitude complement to Nike; mobile or fixed site launchers.
.....	.....	..	.....	.....	.....	.....	.....	.....	Truck transportable tactical weapon for use against low flying aircraft.
.....	Aerojet-General	1	lpr.	2,600	Bell Tel. Labs	Command	.....	25	One Hercules XM5 spr. booster.
.....	Thiokol	1	spr.	.....	Bell Tel. Labs	Command	.....	75+	Four 14.5-ft. Hercules spr. boosters.
.....	Gr. Central/Thiokol	..	spr.	.....	Bell Tel./Sanders Assoc.	Command/radar homing	.....	.....	Anti-missile missile.
.....	.....	..	.....	.....	.....	.....	.....	.....	Bazooka-type weapon for low flying aircraft.
3,000	McDonnell	1	rj.	.....	Farnsworth/Sperry.....	Beam rider/semi-active hom'g	2+	65+	Also surface-to-surface; uses spr. booster.
.....	.....	1	Spr.	.....	Raytheon	.....	.....	10	Smaller version of original Terrier; designed for destroyer use.
3,000[1]	.....	1	spr.	.....	Sperry	Beam rider	2.5	10	Advanced Terrier will have improved guidance and 20-mi. range.

IRBM — Intermediate range ballistic missile
JPL — Jet Propulsion Laboratory
lpr — liquid propellant rocket
MIT — Mass. Institute of Technology
NOTS — Naval Ordnance Test Station
RMD — Reaction Motors Div. of Thiokol Chemical Corp.
spr — solid propellant rocket
tj — turbojet
tp — turboprop
WeE — Western Electric
* Approximate
[1] Gross l ·eoff weight

	GENERAL				STATUS				AIRFRAME					
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Over-all length, less booster, ft.	Over-all span, wings or fins, ft.	Body diameter, ft.	Launching wt., less booster, lb.	
Surface-to-Surface	Atlas	SM-65	USAF	Convair	..	√	√	..	Convair	80	....	10	243,000[1]	Ro
	Corporal	M2	ArmyOrd	Firestone/Gilfillan	..	..	√	√	Firestone	46	....	2.5	12,000	Ry
	Honest John	M31	ArmyOrd	Emerson Elec./Douglas	..	..	√	√	Emerson/Douglas	27	8	2.5	6,000	He
		XM30	ArmyOrd	Emerson Elec./Douglas	√	√	..	..	Douglas	25	4.5	2	.....	Ra
	Jupiter	.....	Army Ord/USAF	Chrysler	..	√	√	√	Chrysler	58	....	8.8	110,000	Ro
	Lacrosse	XM42	ArmyOrd	Martin	..	√	..	..	Martin	19	9	1.7	2,300	Thi
	Little John	XM51	ArmyOrd	Emerson Elec.	..	√	√	√	Emerson Elec.	15	2	1	.....	Ra
	Lobber	.....	ArmyOrd	Convair	..	√	..	..	Convair	6	....	....	.....	...
	Mace	TM-76	USAF	Martin	..	..	√	..	Martin	44	23	4.5	14,000[1]	Alli
	Matador	TM-61	USAF	Martin	..	..	..	√	Martin	40	29	4.5	12,000	Alli
	Minuteman	.....	USAF	.....	√	√	..	..	.....	....	....	....	.....	...
	Pershing	.....	ArmyOrd	Martin	√	√	..	..	Martin	....	....	....	.. ..	Thi
	Polaris	FBM	Navy	Lockheed	√	√	..	..	Lockheed	47	....	....	28,000	Aer
	Redstone	.....	ArmyOrd	Chrysler	..	..	√	√	Chrysler	69	....	6	62,000	Ro
	Regulus I	SSM-N-8a	BuAer	Chance Vought	..	..	..	√	Chance Vought	33	21	....	12,000	Alli
	Regulus II	SSM-N-9a	BuAer	Chance Vought	..	..	..	√	Chance Vought	57	20	....	22,000	GE
	Sergeant	.....	ArmyOrd	JPL/Sperry	..	√	√	..	Sperry	30	6	3	.....	Thi
	Snark	SM-62	USAF	Northrop	..	..	√	√	Northrop	67	42	15	50,000	P&W
	Thor	SM-75	USAF	Douglas	..	..	√	√	Douglas	62	....	8	110,000	Roc
	Titan	SM-68	USAF	Martin	√	√	√	..	Martin	90	....	10	222,000	Aer
Drones	Firebee	KDA-4	Navy	Ryan	..	..	√	√	Ryan	17.6	11.2	....	1,900	Fai
	Firebee	Q-2A	USAF	Ryan	..	..	√	√	Ryan	17.3	11.2	....	1,849	Con
	Firebee	Q-2C	USAF	Ryan	..	..	√	√	Ryan	22.9	12.9	....	2,000	Con
	Kingfisher	Q-5	ArmyOrd	Lockheed	..	√	√	..	Lockheed	38	10	2	7,600	Mar
	Snooper	SD-3	Army Signal Corp	Republic	..	√	√	..	Republic	15	11	....	1,000	Con
	Swallow	SD-4	Army	Republic	..	√	√	..	Republic	....	....	....	3,500	P&W
	Teal	XKDT-1	Navy	Temco	..	√	..	..	Temco	11.8	4.9	0.8	350	Ast
	.....	SD-2	Army Signal Corp	Rheem	..	√	√	..	Rheem	....	....	....	.....	...
	.....	SD-5	Army	Fairchild	√	√	..	..	Fairchild	....	....	....	10,000	P&W
	.....	KDB-1	Navy	Beech	..	..	√	..	Beech	13.5	12.5	1.5	600	McC
	.....	XQ-4	USAF	Radioplane	..	..	..	√	Radioplane	35	12	2	.....	Wes
	.....	RP-76	Army	Radioplane	..	√	..	..	Radioplane	9.7	5	1	319	Aer
	.....	RP-77D	Army	Radioplane	..	√	..	..	Radioplane	9	17.5	2	1,035	Boe
	.....	SD-1	Army	Radioplane	..	..	√	√	Radioplane	13.3	11.5	1	435	McC
	.....	OQ-19	Army/USAF	Radioplane	..	..	√	√	Radioplane	12.3	13.2	1	327	McC

Launching wt., less booster, lb.	POWERPLANT				GUIDANCE		PERFORMANCE		REMARKS
	Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum Mach number	Maximum range, n. mi.	
3,000[1]	Rocketdyne	1	lpr.	60,000	GE/Burroughs	Radio-inertial	20	5,500	Two 150,000-lb. thrust lpr. boosters; GE nose cone; later versions will have Arma inertial guidance system.
2,000	Ryan	1	lpr.	20,000	Gilfillan	Command	3	75	Nuclear and all-weather capability; deployed in Europe.
5,000	Hercules	1	spr.	.....	.....	Unguided	.....	15	Highly mobile tactical weapon; deployed in Europe, Japan.
.....	Radford Arsenal	1	XM31E1 spr.	.....	.....	Unguided	.....	.....	Advance Honest John with greater range, accuracy.
0,000	Rocketdyne	1	lpr.	150,000	Ford Instrument	Inertial	12	1,500	FRBM developed by Army, used by Air Force
2,300	Thiokol	1	XM-10 spr.	.....	FTL	Command	.....	8	Close tactical support.
.....	Radford Arsenal	1	XM26E1 spr.	.....	.....	Unguided	.....	.....	Issued to 101st Airborne Div.; close tactical support.
.....	.....	..	spr.	.....	.....	.....	.....	13	Supply missile project.
1,000[1]	Allison	1	J33-A-41 tj.	5,200	Goodyear/AC	ATRAN/Inertial	0.9	650	Improved Matador; high-low altitude capability; spr. booster.
2,000	Allison	1	J33-A-37 tj.	3,700	GFE/Martin	MSQ radar/Shanicle	0.9	.....	Tactical weapon; deployed in Europe, Taiwan, Korea; spr. booster.
.....	.....	3	spr.	.....	Autonetics	.....	.....	5,500	Solid propellant ICBM; launched from underground silos; Boeing has assembly and test contract.
.....	Thiokol	2	spr.	.....	Bendix	Inertial	.....	.....	Selective range ballistic missile.
0,000	Aerojet-General	2	spr.	.....	MIT/GE	Inertial	.....	1,500	Launched from underwater, 3,000-mi. model planned.
0,000	Rocketdyne	1	lpr.	78,000	Ford Instr.	Inertial	.....	200	Deployed in Europe; warhead separates.
0,000	Allison	1	J33-A-18A tj.	4,600	Sperry	Command	0.9	500	Production ended; nuclear capability; spr. booster.
0,000	GE	1	J79-GE-3 tj.	10,000+	AC	Command or inertial	2+	1,000+	Improved Regulus I; production discontinued.
.....	Thiokol	1	spr.	.....	Sperry	Inertial	.....	200	Air transportable; will replace Corporal.
0,000	P&W	1	J-57	15,000	Nortronics	Stellar inertial	0.9	5,500	Two spr. boosters; first SAC Snark unit at Presque Isle, Me.
0,000	Rocketdyne.....	1	lpr.	150,000	AC	Inertial	.....	1,500	First units in England; GE nose cone.
0,000	Aerojet-General	3	lpr.	360,000	Arma/Bell Tel/Rem. Rand	Inertial/Radar-command	20	5,500	Navy nose cone; range may reach 9,000 mi.
0,900	Fairchild	1	J-44-R-20	1,000	GFE	Radio	0.85	.....	Target.
0,840	Continental	1	J69-T-19B	1,000	GFE	Radio/radar	0.85	.....	Target.
0,000	Continental	1	J69-T-29	1,700	GFE	Radio/Radar	0.85	.....	Advanced Q-2A target for missile evaluation.
0,600	Marquardt	1	rj.	.....	Lockheed	Command	2+	.....	Target evaluation system.
0,000	Continental	1	140-hp	.....	Republic	.....	.....	100	Combat surveillance; zero launch with 2 spr. boosters.
0,500	P&W	1	JT-12 tj.	3,000	Republic	.....	.....	.....	Combat surveillance.
0,350	Astrodyne	1	spr.	50	Temco	Preset	0.95	.....	One 150-lb. thrust spr. booster; air launched target.
.....	.....	..	.....	.....	Sperry	Radio-autopilot	.....	.....	Surveillance drone.
0,000	P&W	1	JT-12 tj.	3,000	.....	.....	.....	.....	Surveillance drone.
0,600	McCulloch	1	O150-4	120 hp	Babcock & Summers	Radio command	.....	.....	Target; 800-lb. model planned as surveillance drone.
.....	Westinghouse	1	XJ81-WE-3 tj.	.....	Radioplane	Radar	.....	.....	Supersonic air-launched missile target; advanced XQ-4B under development.
0,312	Aerojet-General	1	53ONS-35 spr.	.....	Radioplane	Radio	0.9	.....	Missile target; Navy version XKD4B-1.
0,035	Boeing	1	502-10F tp.	.....	Radioplane	Radio	.....	.....	Ground launched target.
0,435	McCulloch	1	O100-2	72 hp	Radioplane	Radio	.....	.....	Combat surveillance drone.
0,327	McCulloch	1	O100-1	72 hp	Radioplane	Radio	.....	.....	Training target; KD2B-5 in Navy version.

U.S. STOL & VTOL Aircraft

Manufacturer and Address	Designation	Type	No. of seats	Dimensions: Span	Length	Height	Wing area, sq. ft.	Weights: Empty weight, lb.	Gross weight, lb.	Powerplant: Number, make, model and max. power, ea.	Rotor-Propeller diameter	No. of propellers	Service ceiling, ft.	Maximum speed, mph.	Remarks
Aerophysics Development Division, Curtiss-Wright Corp. *Santa Barbara, Calif.*	VZ-7AP	Ducted fan	1	16'[1]	17'	7' 8"	.....	1,700	2,255	1 Con. Artouste IIB @ 425 shp.	80"	4	.....	.....	Hinged blades, cyclic pitch control.
Bell Aircraft Corp. *Buffalo, N. Y.*	X-14	Deflected jet	1	34'	27'*	9'*	.....	.....	.....	2 AS Viper	N.A.	None	.....	.....	VTOL flight cycle May 24, 1958.
	XF-109	Tilt jets	1	.....	.....	.....	.....	.....	.....	8 GE J85 @ 2,000 lb. t.	N.A.	None	.....	M2+	Twin jets at each wingtip; 2 in fuselage; 2 in tail.
Bell Helicopter Corp. *Ft. Worth, Tex.*	XV-3	Tilt rotor	4	.....	30'	13' 6"	.....	3,400	4,700	1 P&W R985@400 hp.	300"	2	7,400[2]	184	Complete conversions made. Rotor diameter (2) 23 ft.
Benson Aircraft Corp. *Raleigh, N. C.*	B-10	.....	1	7.2'[1]	12'	4' 6"	.....	350	650	2 McCulloch @ 72 hp.	51"	2	.....	50	First flight Aug. '58.
Chrysler Corp. Defense Operations Div. *Detroit, Mich.*	VZ-6	Ducted fan	1	10'[1]	23'	4' 6"	.....	.....	2,000	1 Lyc. @ 380 hp.	102"	2	.....	.....	Rigid, fixed-pitch rotor-props.
Collins Radio Co. *Cedar Rapids, Ia.*	Aerodyne	Ducted fan	..	.....	42'	.....	.....	.....	.....	2 Con. @ 213 hp.	.....	.....	.....	.....	Duct inside diameter 7.5 ft.
Convertawings, Inc. *Amityville, N. Y.*	V-10 Dynafoil	Tilt wing	5	Tandem[1]	23' 3"	6' 8"	160	2,719	4,552	1 GE T58 @ 1,000 shp.	96"	4	12,000[2]	312	Prototype building.
De Lackner Helicopters, Inc. *Mt. Vernon, N. Y.*	DH-4 Aerocycle	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Several on bailment to universities.
	DH-5 Aerocycle	.....	1	.....	.....	.....	.....	.....	.....	1 Kiek. Mercury @ 55 hp.	180	2	.....	.....	
Doak Aircraft Co., Inc. *Torrance, Calif.*	VZ-4DA	Tilt ducts	2	28'	32'	10'	.....	2,000	2,700	1 Lyc. T53 @ 840 shp.	.....	2	.....	.....	600 lb. useful load.
Fairchild Aircraft Div. Fairchild E & A Co. *Hagerstown, Md.*	VZ-5	Vectored slipstream	2	.....	.....	.....	.....	.....	.....	1 GE T58 @ 1,000 shp.	.....	4	.....	.....	Engine in fuselage.
Flotch-Aire, Inc. *Newton, N. J.*	.....	Ducted fan	1	.....	.....	.....	58	.....	1,800	2 piston @ 115 hp.	.....	.....	.....	235	Duct rotates 90 deg.
	.....	Ducted fan	4	.....	.....	.....	.....	.....	6,000	2 Lyc. T53 @ 840 shp.	.....	.....	27,600	215	Projected weapons carrier.
Goodyear Aircraft Corp. *Akron, Ohio*	Convoplane	Ducted fan	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Numerous layouts.
Grumman Aircraft Eng'rg Corp. *Bethpage, N. Y.*	.....	Tilt wing	..	.....	.....	.....	.....	.....	.....	.....	.....	4	.....	.....	
	OA-1														
Helio Aircraft Corp. *Norwood, Mass.*	L-28A	.....	5	30'	31'	8'10"	231	2,012	3,000	1Lyc. GO480@295 hp.	96"	1	23,500	176	In production
Hiller Aircraft Corp. *Palo Alto, Calif.*	X-18	Tilt wing	2	48'	62'	24' 7"	.....	33,000	.....	2 All. YT40-A-14	192"	2	.....	250	Testbed for USAF.
	1085B	Tilt wing	..	74' 3"	65'	24' 4"	604	21,286	30,190	4 Free turbine@2,650 bhp.	296"	4	43,000	382	Aft-loading transport design study.
Kaman Aircraft Corp. *Bloomfield, Conn.*	K-16B	Tiltwing & deflected slipstream	..	38'	38' 4"	17' 2"	254.6	.....	.....	2 GE T58 @ 1,000 shp.	168"	2	.....	.....	Testbed for BuAer.
Lanier Aircraft Corp. *Marlton, N. J.*	Paraplane	Boundary layer	1	20' 7"	21'	.....	111	780	1,280	1 Lyc. O320 @ 150 hp.	.....	1	23,000	165	Prototype flying.
	Paraplane	Boundary layer	4	27' 11"	22' 11"	9' 6"	.....	1,200	2,200	1 Lyc. O360 @ 180 hp.	.....	1	21,500	171	Project.
Lockheed Aircraft Corp. *Marietta (Ga.), Burbank, Calif. Division*	CL-379	Tilt wing& deflected slipstream	2	.....	.....	.....	.....	5,000*	10,000*	2 Lyc. T53-L-3 @ 900 shp. Turbojet	.....	2	.....	.....	VTOL or STOL capability.
McDonnell Aircraft Corp. *St. Louis, Mo.*	XV-1	Convertiplane; unloaded rotor.	3	26'	30'	10' 8"	.....	.....	.....	1 Con.@550 hp. + tip jets	.....	.....	.....	.....	Translated Apr. 1955.
Leonard Mueller *Eau Claire, Wisc.*	Travois X-2	Ducted fan	4	20'[1]	10'	5' 10"	.....	853	1,860	1 Aircooled 6V6 @ 245 hp.	120"[3]	2	.....	135	Design study.
Piasecki Aircraft Corp. *Philadelphia, Pa.*	VZ-8P	Ducted fan	1	.....	.....	.....	.....	.....	.....	2 Lyc. O360 @ 180 hp.	.....	2	.....	.....	First free flight 10-'58.
	Ring wing	Ducted fan	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Navy project.
Robertson Aircraft Corp. *Ft. Worth, Tex.*	.....	Vectored slipstream	4	.....	.....	.....	.....	.....	.....	2 Lyc. GSO480 @ 340 hp.	.....	2	.....	.....	Range about 1,000 mi.

Military definition of VTOL aircraft is one which can clear a 50-ft. obstacle 50 ft. from start of takeoff; STOL aircraft is one which can clear a 50-ft. obstacle 500 ft. from start to takeoff. Many VTOL aircraft can also function as STOL types, carrying higher payloads in latter configuration. Army-Navy-Air Force VTOL and STOL projects embrace wide variety of propulsion and lift schemes. Most are test beds providing flight research data for future operational vehicles.

Abbreviations:
All. — Allison
AS — Armstrong-Siddeley (now Bristol Siddeley).
Con. — Continental
GE — General Electric.
Lyc. — Lycoming.
N.A. — Not applicable.
P&W — Pratt & Whitney Aircraft.
Kiek. — Kiekhaefer
RR — Rolls-Royce

[1] U. S. Army Flying Platforms; dimension given (span) is width of vehicle.
[2] Hovering ceiling in ground effect.
[3] Coaxial rotor-propellers; given is diameter of large rotor-prop. Small rotor-prop has 7-ft. diameter.
* Approximate

Manufacturer and Address	Designation	Type	No. of seats	Span	Length	Height	Wing area, sq. ft.	Empty weight, lb.	Gross weight, lb.	Number, make, model and max. power, ea.	Rotor-Propeller diameter	No. of propellers	Service ceiling, ft.	Maximum speed, mph.	Remarks
Ryan Aeronautical Co. *San Diego, Calif.*	X-13 Vertijet	Mod. tail Sitter	1	21′	24′	18′	.....	.....	.....	1 R-R Avon @ 10,000 lb. t.	N.A.	None	.....	.....	Operates from platform
	VZ-3	Vectored slipstream	1	23′ 5″	27′ 8″	10′ 8″	.....	.....	2,600	1 Lyc. T53 @ 850 shp.	.....	2	.....	.....	
Sikorsky Aircraft Division *United Aircraft Corp.*	.....	Convertiplane	..	.....	.....	.....	.....	.....	.....	1 P&W JT-12 @ 5,000 lb. t.	.....	.....	.....	575	Single-blade, retracting rotor.
	.....	Unloaded rotor	40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Project; 300 naut. mi. range.
Spacetronics, Inc. *Washington, D. C.*	.....	Ground effect	1	.....	.....	.....	.....	.....	.....	1 piston @ 12 hp.	46″	1	4-5′	.....	Testbed built.
Vanguard Air & Marine Corp. *Paoli, Pa.*	Model 2	Ducted fan	2	22′	24′ 6″	.....	.....	.....	.....	1 Lyc. O540 @ 265 hp.	.....	.....	.....	.....	Testbed. Wing-buried rotor-props.
Vertol Aircraft Corp. *Morton, Pa.*	VZ-2	Tilt wing	2	24′ 11″	26′ 5″	10′	110	2,600	3,300	1 Lyc. T53 @ 825 shp.	114″	2	.....	.....	Numerous conversions made.

Foreign Rotary-Wing Aircraft

Basic Data				Dimensions			Weights		Powerplant		Performance					Remarks
Manufacturer and Address	Model designation	Name	Seats, incl. crew	Rotor diameter	Length, blades folded	Max. height	Weight empty, lb.	Normal gross weight, lb.	Number, make, model and max. rating, ea.	Fuel capacity, gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Hovering ceiling in ground effect, ft.	Service ceiling, ft.	Maximum still air range, mi.	
GERMANY																
Carl Borgward *Bremen*	.....	Kolibri I	3	.....	.....	.....	.....	.....	1 Lyc. VO435-A1A @ 260 hp.	.....	100+	.....	.....	.....	.....	Designer, Prof. Heinrich Focke.
GREAT BRITAIN																
Bristol Aeroplane Co., Ltd. *Filton*	171 Mk. 4	Sycamore	5	48′ 7″	46′ 2″	10′ 1″	4,130	5,400	1 Alvis Leonides 524/1 @ 525 hp.	107	115	750	7,200	.....	370	Military, civil models.
	192	.....	27	48′ 8″	89′ 9″	17′	10,553	18,000	2 Napier Gazelle 2 @ 1,650 shp.	670	138	1,175	11,050	13,250	483	Tandem rotors.
Fairey Aviation Co., Ltd. *Hayes, Middlesex*	.....	Rotodyne	50	90′	90′	22′ 2″	.....	39,000	2 Napier Eland N.El.3 @ 3,500 shp.	1,250*	185+	2,000	.....	.....	460	Later version has R-R Tynes.
	.....	Ultra Light	2	28′ 3″	.....	8′ 2″	.....	1,800	1 Blackburn Palouste 500	.....	100*	.....	.....	.....	.....	Fuselage length 14′ 1″.
Saunders-Roe, Ltd. *E. Cowes, Isle of Wight*	P.531-1	.....	5	32′ 6″	39′	9′ 2″	2,258	3,950	1 Blackburn Turmo 603 @ 425 shp.	160	110	1,250	5,000	.....	260	Main rotor 350 rpm.
	P.531-2	.....	5	32′ 6″	39′	9′ 2″	2,500	5,000	1 Unspecified @ 650 shp.	160	135	1,375	12,000	.....	250	Main rotor 400 rpm.
	P. 502	Skeeter Mk. 12	2	32′	39′	7′ 8″	1,656	2,220	1 DH Gipsy Major @ 215 hp.	28	102	1,150	5,500	.....	210	Main rotor 340 rpm.
Westland Aircraft, Ltd. *Yeovil*	WS-55	Whirlwind	8–10	53′	.....	13′ 4″	4,990	7,500	1 P&W R1340-40 @ 600 hp.	145	111	910	7,800	.....	430	Sikorsky S-55.
	.....	Widgeon	5	49′ 3″	57′ 4″	12′ 11″	4,322	5,900	1 Alvis Leonides @ 515 hp.	83	95	700	6,170	12,000	300	
	.....	Wessex	18	50′	65′ 10″	14′ 4″	7,600	12,600	1 Napier Gazelle @ 1,400 shp.	300	144	600	.....	.....	.....	Sikorsky S-58.
	.....	Westminster	53	72′	.....	.....	.....	36,000	2 Napier Eland @ 3,500 shp.	.....	.....	.....	.....	.....	.....	Passenger, "crane" models.
FRANCE																
Sud Aviation *Paris*	S.E. 3120	Alouette	2	39′ 4″	34′ 7″	9′ 7″	1,650	2,750	1 Salmson 9 NH @ 200 hp.	32	78	885	.....	.....	.....	
	S.E. 3130	Alouette II	5	39′ 6″	31′ 9″	9″	1,810	3,300	1 Turbomeca Artouste II @ 400 eshp.	152	106	880	3,300	9,500	345	Republic handles in U.S.
	S.O. 1221	Djinn	2	32′ 9″	17′ 5″	9′ 7″	662	1,540	1 Turbomeca Palouste @ 528 eshp.	.....	82	.....	3,280	.....	310	Republic handles in U.S.
	S.E. 3200	.....	20+	.....	.....	.....	.....	.....	3 Turbomeca Turmo II @ 396 eshp.	.....	.....	.....	.....	.....	.....	
ITALY																
Aer Luidi *Rome*	L. 55	.....	4	32′ 10″	39′	9′ 6″	1,325	2,200	1 Lyc. O360 @ 180 hp.	37	90	.....	9,200	13,000	.....	Hiller cyclic control.
Augusta-Bell *Gallarate*	102	.....	9	.....	.....	.....	4,075	6,215	1 P&W R1340 @ 600 hp.	.....	120	.....	9,200	14,100	300	Bell rotor system.
	AZ-101D	.....	20	62′ 3″	63′ 3″	15′ 6″	10,000	17,150	3 Turbomeca Turmo @ 730 eshp.	.....	140	.....	1,150	10,000	18,000	Four-blade rotor.
Fiat Aviation Division *Turin*	7002	.....	7	39′ 5″	.....	9′ 5″	1,320	3,800	1 Fiat 4700 gas generator @ 850 hp.	.....	106	.....	.....	.....	185	Two-blade rotor.
NETHERLANDS																
Nederlandse Helicopter Industrie N.V. *Rotterdam*	H-3	Kolibrie	2	32′ 10″	32′ 10″	8′ 5″	530	1,434	2 NHI TJ-5 ramjets @ 60 hp.	106	70	800	4,000	.....	40	Agriculture.

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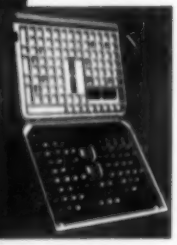

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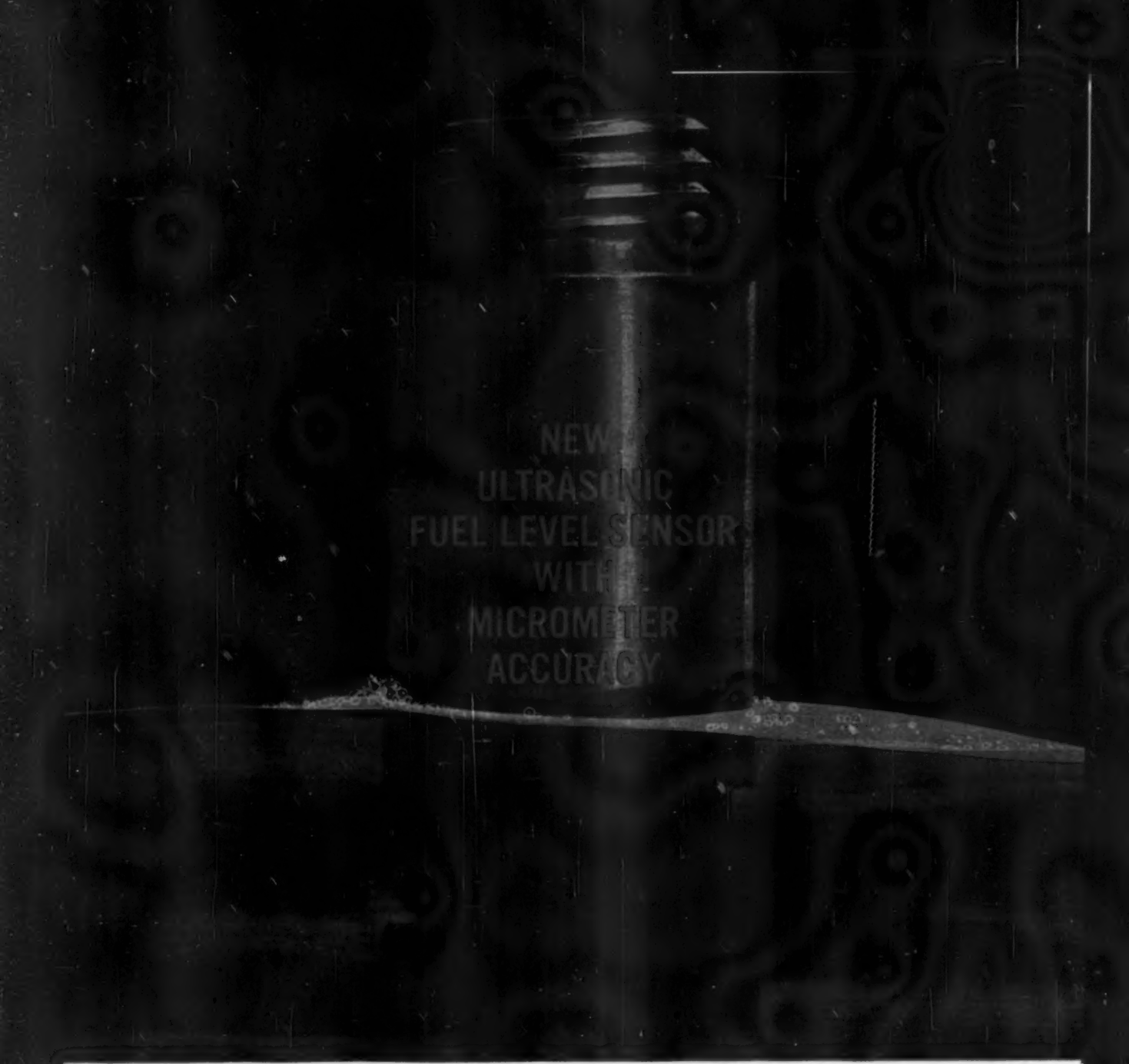
U.S. Civil and Military Rotary-Wing Aircraft

Manufacturer and Address	Model	Name	Seats	Crew	Rotor Diam.	Length	Height	Rotor Area	Gross Weight	Useful Load	Powerplant	Max. Speed	Cruising Speed	Range	Remarks
Bell Helicopter Corp. *Ft. Worth, Texas*	HU-1A	Iroquois	1	5	873	44′	53′	11′ 3″	3,968	5,883	1 Lyc. T53 @ 700 eshp.	142 @ N.R.	14,800	195	Former H-40.
	HTL-7	.....	1	1	.....	37′ 2″	43′ 4″	9′ 4″	1,916	2,565	1 Lyc. O435-6 @ 240 hp.	103 @ N.R.	8,200	154	Instrument trainer.
	47G	Sioux	1	2	465	35′ 1″	41′ 5″	9′ 5″	1,435	2,350	1 AM 6V4-200-C32 @ 200 hp.	86 @ S.L.-1,400	3,600	480	Army H-13G.
	47G-2	Sioux	1	2	431	35′ 1″	41′ 5″	9′ 5″	1,564	2,450	1 Lyc. VO435 @ 200 hp.	100 @ S.L.-1,400	10,850	238	Army H-13H.
	47H	"Bellairus"	1	2	448	35′ 1″	41′ 3″	9′ 4″	1,499	2,350	1 AM 6V4-200-C32 @ 200 hp.	98 @ S.L.-1,400	4,300	211	Commercial only.
	47J	Ranger	1	3	546	37′ 2″	43′ 4″	9′ 4″	1,615	2,565	1 Lyc. VO435 @ 240 hp.	105 @ S.L.-7,000	7,400	222	Also 2,800 lb. gross.
Benson Aircraft Corp. *Raleigh, N. C.*	B-7	.....	1	0	125	20′	20′	5′ 10″	95	270	None	90 @ S.L.	.....	.....	Gyroglider.
	B-7W	.....	1	0	90	20′	20′	7′ 8″	130	305	None	60 @ S.L.	.....	.....	Hydrogyroglider.
	B-7M	.....	1	0	30	20′	20′	5′ 10″	180	385	1 Nelson H-59A @ 42 hp.	80 @ S.L.	.....	120	Powered gyroglider.
	B-8M	.....	1	0	75	21′	21′	6′ 4″	250	550	1 McCulloch @ 72 hp.	85 @ S.L.	.....	130	Powered gyroglider.
	B-9	.....	1	0	100	30′ 6″	11′ 6″	8′	385	700	1 Kiekhaefer @ 60 hp.	65 @ S.L.	9,000	100	Helicopter.
Brantly Helicopter Corp.	B-2	YHO-3	1	1	50	23′ 9″	27′ 9″	6′ 11″	980	1,600	1 Lyc. VO360-A1A @ 180 hp.	100 @ S.L.	4,000	300	All-metal.
Cessna Aircraft Co. *Wichita, Kans.*	CH-1	YH-41	1	1	400	35′	42′ 6″	8′ 6″	2,045	3,000	1 Con. FSO470 @ 260 hp.	122 @ S.L.	13,200	290	
Convertawings, Inc. *Amityville, N. Y.*	A	.....	1	0	.....	19′ 5″	35′ 6″	.....	.....	2,000	2 Continental C-90 @ 95 hp.	.....	.....	.....	Quadrotor testbed.
Doman Helicopters, Inc. *Danbury, Conn.*	LZ-5	YH-31	1	7	1,400	48′	58′ 9″	10′ 5″	3,387	5,200	1 Lyc. SO580-A1B @ 400 hp.	76 @ 1,000	4,000	350	
	D-12	.....	3	0	.....	26′ 6″	26′ 4″	7′ 9″	.....	1,450	1 All. 250-C1 @ 250 shp.	140 @ N.R.	23,000	300	Study.
Gyrodyne Co. of America, Inc. *St. James, N. Y.*	GCA-41	XRON-1	1	0	60	17′	17′	7′ 3″	408	688	1 Porsche GP-702 @ 62 hp.	68 @ N.R.	6,000	60	Liaison rotorcycle.
Hiller Aircraft Corp. *Palo Alto, Calif.*	.....	XROE-1	1	0	.....	18′ 6″	18′ 6″	9′ 9″	300	556	1 Nelson H-53 @ 43 hp.	70 @ S.L.	9,200	25	Liaison rotorcycle.
	.....	H-23D	1	2	407	35′ 5″	40′ 6″	9′ 9″	1,773	2,850	1 Lyc. VO435 @ 250 hp.	95 @ S.L.	10,100	205	1,000-hr.+ transmission.
	UH-12E	.....	1	2	.....	35′ 5″	40′ 6″	6′ 11″	1,700	2,700[1]	1 Lyc. VO540A1A @ 380 hp.	95 @ S.L.	5,200	192	All-metal blades.
Hughes Aircraft Div. *Culver City, Calif.*	269A	YHO-2	1	1	.....	25′	28′	8′	915	1,550	1 Lyc. O360-C2B @ 180 hp.	85 @ S.L.	5,000	150	45-min. engine change.
Kaman Aircraft Corp. *Bloomfield, Conn.*	H-43A	Huskie	2	3	2,000	47′	47′	11′ 10″	5,800	6,800	1 P&W R1340 @ 600 hp.	110 @ 4,000	14,000	220	Local base rescue.
	H-43B	Huskie	2	6	2,000	47′	47′	12′ 5″	5,900	7,100	1 Lyc. T53 @ 860 shp.	107 @ 6,800	20,000	250	Local base rescue.
	HU2K-1	.....	2	4	4,000	44′	52′ 2″	12′ 5″	5,052	9,152	1 GE T58-GE-6 @ 1,050 eshp.	.....	.....	.....	Navy utility.
	HOK-1	.....	2	3	2,000	47′	47′	12′ 5″	.....	6,800	1 P&W R1340 @ 600 hp.	100 @ 4,000	12,000	220	HUK-1 in Navy version.
	HTK-1	.....	0	0	.....	41′	41′	12′ 3″	.....	.....	1 Lyc. 0435 @ 245 hp.	.....	.....	.....	Robot development.
	K-17	.....	2	0	.....	37′	37′	8′ 6″	950	2,000	1 Turbomeca Turmo @ 400 eshp.	80 @ S.L.	.....	.....	Propulsion research.
Kellett Aircraft Corp. *Willow Grove, Pa.*	KH-15	.....	1	0	.....	.....	.....	.....	.....	.....	2 RMI rockets @ 16 lb. t.	.....	.....	.....	Research vehicle.
	KD-1D	.....	1	1	.....	40′	30′	10′ 9″	1,500	2,200	1 Jacobs L-4MA @ 225 hp.	110 @ N.R.	14,000	190	Autogiro.
	KD-1O	.....	1	1	.....	40′	33′	9′ 11″	1,755	2,830	1 Con. IO520 @ 260 hp.	150 @ N.R.	21,000	420	Autogiro.
McDonnell Aircraft Corp. *St. Louis, Mo.*	120	.....	1	0	.....	31′	31′	9′	2,450	6,300	3 AiResearch turbines	138 @ S.L.	12,000	98	Private venture.
Omega Aircraft Co., Inc. *New Bedford, Mass.*	BS-12A	Blue Jay	1	4	1,050	39′ 6″	39′	13′	3,300	4,750	2 Lyc. A540 @ 260 hp.	.....	4,800	165	In production.
	.....	.....	...	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Republic Aviation Corp. *Farmingdale, N. Y.*	Alouette	.....	1	4	1,080	33′ 6″	31′ 10″	9′	1,830	3,000	1 Turbomeca Artouste @ 400 shp.	105 @ 14,500	15,500	325	Sud Aviation license.
	Djinn	YHO-1	1	1	970	.....	17′ 3″	8′ 6″	774	1,676	1 Turbomeca Palouste @ 240 shp.	62 @ S.L.	20,000	125	Sud Aviation license.
Sikorsky Aircraft *Stratford, Conn.*	S-63	.....	1-2	12	4,000	53′	62′ 3″	14′ 2″	6,465	11,000	1 GE T38-8 @ 1,250 shp.	155 @ S.L.	6,500	225	
	S-62	.....	1-2	12	2,000	53′	62′ 3″	14′ 2″	4,550	7,500	1 GE T58-6 @ 671 shp.	117 @ S.L.	14,000	230	Land, amphibious versions.
	S-61	.....	2-3	20-25	.....	.....	.....	.....	.....	.....	2 or 3 GE T58-6	.....	.....	.....	Civil, available in early 1961.
	S-60	.....	2	.....	8,000	72′	88′	22′	.....	31,000	2 P&W R2800-50 @ 1,900 hp.	.....	.....	.....	Test model of flying crane, later versions turbine-powered.
	.....	HS8-2	.....	.....	.....	.....	.....	.....	.....	.....	2 GE T58	.....	.....	.....	
	S-58	H-43A	1-2	18	4,000	56′	65′ 10″	15′ 11″	7,673	13,000	1 Wr. R1820-85 @ 1,525 hp.	123 @ S.L.	4,900	280	
	S-56	HR2S-1	2-3	36	9,149	72′	88′	22′	21,048	31,000	2 P&W R2800-50 @ 1,900 hp.	130 @ S.L.	2,100	207	
	S-55C	H-19A	1-2	10	1,700	53′	62′ 3″	13′ 4″	4,950	7,200	1 P&W R1340 @ 600 hp.	101 @ S.L.	2,000	400	
	S-55A	H-19B	1-2	10	2,100	53′	62′ 3″	13′ 4″	5,250	7,900	1 Wr. R1300-3 @ 700 hp.	112 @ S.L.	5,800	360	
Vertol Aircraft Corp. *Morton, Pa.*	107	YHC-1	2	22	.....	48′ 4″	81′ 8″	16′ 10″	9,100	15,550	2 Lyc. T53 @ 825 shp.	.....	.....	.....	Also 2 GE T58 @ 1,024 hp.
	105	.....	2	20	.....	44′	.....	.....	8,750	14,700	2 Lyc. T53 @ 825 shp.	140 @ S.L.	.....	.....	Turbine testbed.
	44	.....	2	15-19	5,420	44′	.....	.....	8,980	14,300	1 Wr. R1820	110 @ N.R.	4,900	.....	
	.....	H-21A	1-2	14	.....	44′	86′ 4″	16′	8,500	14,500	1 Wr. R1820-103 @ 1,150 hp.	140 @ S.L.	14,900	480	
	43	H-21B	1-2	20	.....	44′	86′ 4″	16′	8,600	15,000	1 Wr. R1820-103 @ 1,425 hp.	140 @ S.L.	6,000	400	
	43	H-21C	1-2	20	4,500	44′	86′ 4″	16′	8,600	15,000	1 Wr. R1820-103 @ 1,425 hp.	140 @ S.L.	6,100	400	
	.....	H-21D	2	20	.....	44′	.....	.....	8,611	14,700	2 GE T58 @ 1,024 shp.	140 @ S.L.	.....	.....	Turbine testbed.

All. — Allison.
AM — Aircooled Motors.
Con. — Continental.
GE — General Electric.
Lyc. — Lycoming.

N.R. — Not reported.
P&W — Pratt & Whitney Aircraft.
RMI — Reaction Motors.
Wr. — Wright.
[1] Normal gross weight.



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U.S. Civil and Military Transports

Manufacturer and Address	Model	Name	No. of crew	No. of passengers	Cargo capacity, lb.	Number, make, model of powerplants	Performance: Maximum speed, mph.	Best cruise speed, mph.	Landing speed, flaps and landing gear down, mph.	Engine-out on route climb, fpm.	FAA field length takeoff, ft.	FAA field length landing, ft.	Maximum still-air range, mi.	Weights: Weight empty, lb.	Maximum gross wt., lb.	Maximum landing weight, lb.	Dimensions: Wingspan	Over-all length	Maximum height
Boeing Airplane Co. *Renton, Wash.*	707	Jet Stratoliner[1]	3	.....	.....	4 P&W JT3C-6[2]	610	600	.....	.....	.....	.....	4,000	111,082	190,000	175,000	130′	128′	38′ 3″
	707-120	Jet Stratoliner	3	121–179	19,200	4 P&W JT3C-6[2]	610	589	.....	.....	.....	.....	4,000	113,640	248,000	175,000	130′ 10″	144′ 6″	38′ 5″
	707-220	Jet Stratoliner	3	121–179	19,200	4 P&W JT4A-3[2]	630	615	.....	.....	.....	.....	4,000	117,400	248,000	175,000	130′ 10″	144′ 6″	38′ 8″
	707-320	Intercontinental	4	131–189	18,000	4 P&W JT4A-3[2]	630	610	.....	.....	.....	.....	5,000	131,364	286,000	195,000	142′ 5″	152′ 11″	38′ 8″
	707-420	Intercontinental	4	131–189	18,000	4 R-R Co. 10[2]	630	606	.....	.....	.....	.....	5,000	129,900	286,000	195,000	142′ 5″	152′ 11″	38′ 8″
	720		3	110–149	16,680	4 P&W JT3C-7[3]	649	614	.....	.....	.....	.....	3,300	103,145	203,000	165,000	130′ 10″	136′ 2″	38′ 5″
	KC-135A	Stratotanker	4	80+	50,000	4 P&W J57	600+	.....	.....	.....	.....	.....	.....	.....	.....	250,000	.....	130′ 10″	136′ 3″	38′ 5″
	VC-137A[4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Convair Division General Dynamics Corp. *San Diego, Cal.*	880		5	88–110	8,630	4 GE CJ805-3	615	.....	128	.....	5,200	5,300	3,450	81,800	184,500	132,800	120′	129′ 4″	36′
	600		5	96–121	9,280	4 GE CJ805-21	635	.....	125	.....	5,000	4,650	4,400	113,300	239,000	180,000	120′	139′ 5″	30′ 6″
	600	"Swing-Tail"	.....	147[5]	70,000[6]	4 GE CJ-805-21	.....	.....	.....	.....	.....	.....	5,750[7]	.....	275,500	.....	.....	.....	.....
	440	Metropolitan	4	44–52	5,400	2 P&W R-2800-CB-17	310	280	85	180	5,000	4,010	2,752	31,305	49,100	47,650	105′ 4″	79′ 2″	29′ 2″
	C-131A	Samaritan	3	.....	.....	2 P&W R-2800-99W	312	.....	.....	.....	.....	.....	.....	29,000	43,575	.....	91′ 9″	74′ 8″	27′ 3″
	C-131B	.....	.....	.....	.....	2 P&W R-2800-99W	295	.....	.....	.....	.....	.....	.....	29,248	47,000	.....	105′ 4″	79′ 2″	28′ 2″
	YC-131C	.....	.....	.....	.....	2 All.YT56-A-3	386	.....	.....	.....	.....	.....	.....	.....	47,000	.....	105′ 4″	79′ 2″	28′ 2″
	C-131D	.....	3	.....	.....	2 P&W R2800-CB-16	314	.....	.....	.....	.....	.....	.....	29,600	46,500	.....	105′ 4″	79′ 2″	29′ 2″
	R3Y-2	Tradewind	6	.....	.....	4 All. T40-A-10	350	.....	.....	.....	.....	.....	.....	31,735	180,000	.....	145′ 9″	139′ 8″	51′ 5″
	R4Y-1	.....	3	.....	.....	2 P&W R2800-52W	.....	.....	.....	.....	.....	.....	.....	30,684	47,000	.....	105′ 4″	79′ 2″	29′ 2″
Douglas Aircraft Co., Inc. *Long Beach, Cal.*	DC-8[8]	Domestic	3	116–176	.....	4 P&W JT3C-6	.....	561[9]	.....	.....	.....	.....	.....	122,700	165,000	.....	139′ 9″	150′ 6″	42′ 4″
	DC-8	Domestic	3	116–176	.....	4 P&W JT4A-3	.....	589[9]	.....	.....	.....	.....	.....	124,977	265,000	.....	139′ 9″	150′ 6″	42′ 4″
	DC-8	Intercontinental	3–5	116–176	.....	4 P&W JT4A-3	.....	589[9]	.....	.....	.....	.....	.....	130,000	287,500	.....	139′ 9″	150′ 6″	42′ 4″
	DC-8	Extended range	3–5	116–176	.....	4 P&W JT4A-9	.....	588[9]	.....	.....	.....	.....	.....	132,300	310,000	.....	139′ 9″	150′ 6″	42′ 4″
	DC-8	Intercontinental	3–5	116–176	.....	4 R-R Conway R. Co.10	.....	591[9]	.....	.....	.....	.....	.....	128,000	287,500	.....	139′ 9″	150′ 6″	42′ 4″
	DC-8	Extended range	3–5	116–176	.....	4 R-R Conway R. Co.12	.....	590[9]	.....	.....	.....	.....	.....	130,160	310,000	.....	139′ 9″	150′ 6″	42′ 4″
	DC-7C[10]	Seven Seas	3–5	69–99	18,440	4 Wr. 988TC18EA4	406	371	.....	507	5,500	5,360	6,010	72,643	143,000	109,000	127′ 6″	112′ 3″	31′ 10″
	DC-7B[10]	Extended range	3	69–99	17,730	4 Wr. 972TC18DA4	412	360	.....	525	6,350	5,870	5,130	68,073	126,000	102,000	117′ 6″	108′ 11″	28′ 7″
	DC-7[10]	Domestic	3	69–99	12,740	4 Wr. 972TC18DA4	409	367	.....	448	6,060	5,840	4,430	64,480	122,000	97,000	117′ 6″	108′ 11″	28′ 7″
	DC-6C[10]	Extended range	7	86	11,930	4 P&W R2800-CB-17	370	315	97	493	6,100	5,160	5,000	58,340	107,000	88,200	117′ 6″	106′ 6″	28′ 8″
	DC-6B[10]	Domestic	5	54	16,780	4 P&W R2800-CB-16	370	315	95	460	5,680	4,995	3,720	55,357	100,000	85,000	117′ 6″	106′ 6″	28′ 8″
	DC-6A[10]	Liftmaster	3–5	Cargo	30,500	4 P&W R2800-CB-17	370	315	97	493	6,100	5,160	5,000	51,316	107,000	88,200	117′ 6″	106′ 6″	28′ 8″
	C-124C	Globemaster 2	5–8	Cargo	.....	4 P&W R4360-63A	304	.....	.....	.....	.....	.....	.....	101,965	185,000	.....	174′ 2″	130′	48′ 4″
	C-133A	Cargomaster 1	4–7	Cargo	62,800[11]	4 P&W T34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	179′ 8″	157′ 6″	48′ 4″
	C-133B	Cargomaster 2	4–7	Cargo	77,680[12]	4 P&W T34-P-9W	312	.....	.....	.....	.....	.....	.....	120,363	300,000	286,000	179′ 8″	157′ 6″	48′ 4″
Fairchild Aircraft Division Fairchild Engine & Aircraft Corp. *Hagerstown, Md.*	F-27	.....	3	36–44	8,887	2 R-R Dart RDa. 6 Mk. 511	.....	280	73	375	3,810	3,490	2,500	22,646	35,700	34,000	95′ 2″	77′ 2″	27′ 6″
	F-27A	.....	3	36–44	8,337	2 R-R Dart RDa. 7 Mk. 528	.....	.....	.....	.....	.....	.....	.....	23,363	35,700	34,000	95′ 2″	77′ 2″	27′ 6″
Emile Gilutin & Associates, Inc. *Dallas, Tex.*	101	Victoria	2	46	.....	4 Lyc. T55	.....	375	.....	.....	.....	.....	1,400	.....	.....	.....	.....	.....	.....
Grumman Aircraft Eng'rg. Corp. *Bethpage, L. I., N. Y.*	TF-1	Trader	2	.....	3,500	2 Wr. R1820-82	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	69′ 8″	42′	16′ 3″
Lockheed Aircraft Corp. *Burbank, Calif.*	.....	188 Electra	3–4	66–98	.....	4 All. 501-D13	450	406	130	730	5,250	4,950	3,400	55,993	116,000	95,650	99′	104′ 6″	33′
	1049G	Super Constellation	5–11	47–99	.....	4 Wr. 972TC18DA3	370	335	101	630	6,300	5,250	5,380	73,016	137,500	113,000	123′ 5″	116′ 2″	24′ 9″
	1049H	Super Constellation	5–11	Cargo	40,000	4 Wr. 972TC18DA3	370	335	101	630	6,300	5,250	5,250	70,000	137,500	113,000	123′ 5″	116′ 2″	24′ 9″
	1649A	Starliner	5–11	47–99	.....	4 Wr. 988TC18EA2	377	350	101	630	6,320	6,050	6,400	85,553	156,000	123,000	150′	116′ 2″	24′ 9″
Marietta (Ga.) Division	282A	Hercules	3	Cargo	46,700	4 All. 501-D22/D22B	365	335	122	450	6,900	5,950	3,800	65,860	150,000	127,000	132′ 7″	97′ 9″	38′ 4″
	C-130A	Hercules	4	.....	35,000	4 All. T56-A-1A	360	335	106	1,030	.....	.....	2,450	61,000	124,200	124,200	132′ 7″	97′ 9″	38′ 4″
	GC-130A[13]	Hercules	6	.....	.....	4 All. T56-A-1A	360	335	106	1,800	.....	.....	575[14]	.....	124,200	118,000	132′ 7″	100′ 3″	38′ 0″
	RC-130A[15]	Hercules	8	20	.....	4 All. T56-A-9	360	335	106	1,450	.....	.....	865[16]	65,340	124,200	118,000	132′ 7″	100′ 3″	38′ 0″
	C-130B	Hercules	4	.....	38,000	4 All. T56-A-7	370	350	117	1,100	.....	.....	3,500	67,700	135,000	135,000	132′ 7″	97′ 9″	38′ 4″
	SC-130B[16]	Hercules	8	44	37,800	4 All. T56-A-7	370	350	117	1,100	.....	.....	1,185[17]	66,740	135,000	118,000	132′ 7″	97′ 9″	38′ 4″
	329[18]	Jetstar	2	10	.....	4 P&W JT-12/4 GE J85	573	510	135	.....	.....	.....	2,705	17,200	38,930	30,000	53′ 8″	60′ 4½″	20′ 6″

All. —Allison.
GE —General Electric.
Lyc. —Lycoming.
P&W—Pratt & Whitney Aircraft.
R-R —Rolls-Royce.
Wr. —Wright.

[1] Prototype.
[2] Wet engine.
[3] Dry engine.
[4] Three aircraft ordered for USAF Special Mission Squadron, which transports the President of the United States and other top-ranking government officials.
[5] Six-abreast seating; could carry 135 five-abreast.
[6] Payload over 2,935 stat. mi. range.
[7] Range with 10-ton payload.
[8] DC-8 versions include a "swing-tail" all-cargo version powered by P&W JT3D-1 turbofan engines.
[9] Level flight speed using maximum cruise thrust.
[10] DC-6/DC-7 series production discontinued in 1958 after total of 1,041 of all models built.
[11] Over 1,725-stat.-mi. range. Cargo load over 4,025 stat. mi. can be 42,396 lb. Typical transatlantic loads of operational C-133As exceed 62,000 lb. On 12-7-58, a C-133A lifted 117,900 lb. of cargo, exceeding aircraft empty weight by more than 1,000 lb.
[12] Over 1,725-stat.-mi- range. Cargo load over 4,025 stat. mi. could be 51,841 lb.
[13] Drone launcher.
[14] Combat radius, includes four-hours loiter.
[15] Photographic survey missions.
[16] U. S. Coast Guard search and rescue version.
[17] Mission radius on low-altitude search mission.
[18] Military utility trainer-transport.

U.S. Reciprocating Engines

Manufacturer and Address	Designation	No. of cylinders	Cylinder arrangement	Propeller drive	Power Ratings: Max. takeoff power (hp.)—SL	Power Ratings: At rpm.	Power Ratings: Normal rated power (hp.)	Power Ratings: At rpm.	Power Ratings: At altitude (ft.)	Fuel grade	Diameter or dimensions, in. (without cowling)	Blower ratio	Gross weight dry (lb.)
Aircooled Motors, Inc. *Syracuse, N. Y.*	4A4-100-B3	4	Ho	Direct	100	2,550	.....	.....	.....	80	.....	....	200
	6A4-150-B3	6	Ho	Direct	150	2,600	.....	.....	.....	80	.....	....	278
	6A4-165-B3	6	Ho	Direct	165	2,800	.....	.....	.....	80	.....	....	278
	6AG4-185-B12	6	Ho	G .632:1	185	3,100	.....	.....	.....	80	.....	....	232
	6A4-200-C6	6	Ho	Direct	200	3,100	.....	.....	.....	91	.....	....	307
	6V4-200-C32[1], C33[1], 0335-5, -6	6	Vo	Direct	200	3,100	.....	.....	.....	91	.....	....	297
	6V6-245-B 16F[1] 0425-1	6	Vo	Direct	245	3,275	.....	.....	.....	80	.....	....	372
	6V-335-A, -B	6	Vo	Direct	210	3,100	.....	.....	.....	91	.....	....	295
Avco Manufacturing Corp. **Lycoming Division** *Stratford, Conn.*	O-235-C1	4	Ho	Direct	115	2,800	80	2,350	6,500	80	22.53x32	....	237
	O-290-D2B	4	Ho	Direct	140	2,800	100	2,350	6,500	80/87	22.81x32.24	....	264
	O-320-A1A	4	Ho	Direct	150	2,700	110	2,450	7,000	80/87	23.12x32.24	....	272
	O-320-B1A	4	Ho	Direct	160	2,700	120	2,450	7,000	91/96	23.12x32.24	....	278
	O-340-A1A	4	Ho	Direct	170	2,700	125	2,450	7,000	91/96	24.68x32.55	....	278
	O-340-B1A	4	Ho	Direct	160	2,700	120	2,450	7,000	80/87	24.68x32.55	....	275
	O-360-A1A	4	Ho	Direct	180	2,700	135	2,450	7,500	91/96	24.68x33.57	....	282
	O-360-B1A	4	Ho	Direct	168	2,700	125	2,450	7,500	91/96	24.68x33.57	....	279
	O-435-A	6	Ho	Direct	190	2,550	140	2,300	7,000	80	29.59x32.24	....	.....
	VO-435-A1C	6	Vo	Direct	280	3,400	200	3,200	7,000	80/87	25.19x33.32	....	.....
	VO-435-A1D	6	Vo	Direct	260	3,400	200	3,200	7,000	80/87	25.19x33.32	....	.....
	GO-435-C2B2	6	Ho	Gear	260	3,400	180	2,750	6,000	80/87	28.02x33.12	....	.....
	GO-480-B1A6	6	Ho	Gear	270	3,400	195	2,750	7,000	80/87	28.02x33.12	....	.....
	GO-480-B1D	6	Ho	Gear	270	3,400	195	2,750	7,000	80/87	28.02x33.12	....	.....
	GO-480-G1B6	6	Ho	Gear	295	3,400	210	2,750	7,000	100/130	26.34x33.12	....	.....
	GO-480-G2D6	6	Ho	Gear	295	3,400	210	2,750	6,800	100/130	28.02x33.12	....	.....
	GO-480-D1A	6	Ho	Gear	275	3,400	197	2,750	7,000	80/87	26.34x33.12	....	453
	GO-480-F1A6	6	Ho	Gear	275	3,400	197	2,750	7,000	80/87	28.02x33.12	....	436
	GSO-480-B1A6	6	Ho	Gear	340	3,400	240	2,750	10,000	100/130	29.40x33.12	....	498
	GSO-480-B1B6	6	Ho	Gear	340	3,400	240	2,750	10,000	100/130	33.26x33.12	....	500
	GSO-480-B1C6	6	Ho	Gear	340	3,400	240	2,750	10,000	100/130	22.56x33.12	....	497
	O-540-A1A	6	Ho	Direct	250	2,575	190	2,350	6,000	91/96	25.81x33.37	....	396
	GSO-580-D, O580-1	8	Ho	G .642:1	400	3,300	260	2,750	11,500	100/130	34.22x33.18	7.91	604
	SO-580-A1B	8	Ho	Direct	400	3,300	280	3,000	11,000	100/130	24.49x33.12	7.91	878
	VSO-580-A1A[4] O580-3	8	Ho	Direct	400	3,300	280	3,000	11,000	100/130	30.75x33.18	7.91	801
Continental Motors Corp. *Muskegon, Mich.*	O-200-A	4	Ho	Direct	100	2,750	.....	.....	.....	80/87	.....	....	190
	GO-300-A, B & C	6	Ho	G .750:1	175	3,200	.....	.....	.....	80/87	.....	....	314
	IO-470-C	6	Ho	Direct	250	2,600	.....	.....	.....	80/87	.....	....	432
	IO-470-D, E & F	6	Ho	Direct	260	2,625	.....	.....	.....	100/130	.....	....	426
	A65-8	4	Ho	Direct	65	2,300	.....	.....	.....	80/87	.....	....	170
	C85-12F	4	Ho	Direct	85	2,575	.....	.....	.....	80/87	.....	....	184
	C90-12F	4	Ho	Direct	95	2,625	.....	.....	.....	80/87	.....	....	188
	O-300-A, B & C	6	Ho	Direct	145	2,700	.....	.....	.....	80/87	.....	....	268
	O-470-G	6	Ho	Direct	240	2,600	.....	.....	.....	91/96	.....	....	432
	O-470-H	6	Ho	Direct	240	2,600	.....	.....	.....	91/96	.....	....	472
	O-470-J	6	Ho	Direct	225	2,550	.....	.....	.....	80/87	.....	....	378
	O-470-K	6	Ho	Direct	230	2,600	.....	.....	.....	80/87	.....	....	404
	O-470-L	6	Ho	Direct	230	2,600	.....	.....	.....	80/87	.....	....	404
	O-470-M	6	Ho	Direct	240	2,600	.....	.....	.....	91/96	.....	....	410
	SO-470-A	6	Ho	Direct	265	2,600	250	2,600	10,000	100/130	.....	....	484
	FSO-526-A	6	Ho	Direct	270	3,200	270	3,000	7,900	91/96	.....	....	553
	GSO-526-A	6	Ho	G .688:1	340	3,100	300	3,000	14,500	100/130	.....	....	556
	O-470-4	6	Ho	Direct	225	2,600	.....	.....	.....	91/96	.....	....	415
	O-470-15	6	Ho	Direct	213	2,600	.....	.....	.....	80/87	.....	....	405
	E-185-9	6	Ho	Direct	205	2,600	.....	.....	.....	80/87	.....	....	352
	E-225-4	6	Ho	Direct	225	2,650	.....	.....	.....	80/87	.....	....	355
Pratt & Whitney Aircraft Div. **United Aircraft Corp.** *East Hartford, Conn.*	R2000-D5	14	Rad	G .500	1,450	2,700	1,200	2,550	6,400	100/130	49.10	....	1,585
	R2000 2SD13-G	14	Rad	G .500	1,450	2,700	1,200	2,550	5,000	100/130	49.10	....	1,605
	R2800-CB3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80	....	2,357
	R2800-CB4	18	Rad	G .480:1	2,500	2,800	1,800	2,600	8,500	108/135	52.80	....	2,357
	R2800-CB16	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80	....	2,390
	R2800-CB17	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52.80	....	2,390
	R2800-CB2	18	Rad	G .450:1	2,500	2,800	1,900	2,600	7,000	115/145	52.8	7.29	2,370
	R2800-CB5, -54, -55[1]	18	Rad	Direct	2,100	2,700	1,900	2,600	7,000	115/145	52.8	7.29	2,330
	R2800-CB15, -99W	18	Rad	G .450:1	2,500	2,800	1,900	2,600	7,000	115/145	52.8	7.29+8.58	2,403
Wright Aeronautical Div. **Curtiss-Wright Corp.** *Wood-Ridge, N. J.*	749C18BD1 R3350-75	18	Rad	G .4375:1	2,500	2,800	1,470	2,400	11,000	100/130	55.92	6.46[4]	2,915
	826C9HD3 & 5 R1820-76A,-76B	9	Rad	G .666:1	1,425	2,700	.....	.....	.....	100/130	55.27	7.21[2]	1,380
	836C18CA2 R3350-26WB	18	Rad	G .4375:1	2,700	2,900	1,900	2,600	17,000	115/145	55.6	6.46[4]	2,953
	853C7BA1 R1300-1A	7	Rad	G .5625:1	800	2,600	.....	.....	.....	91/98	50.45	7.21	1,065
	856TC18DB1, 2[5] R3350-30WA	18	Rad	G .4375:1	3,500	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,408
	863C9HD1 R1820-103	9	Rad	Direct	1,425	2,700	.....	.....	.....	100/130	54.95	7.21[2]	1,380
	865C7BA1 R1300-2	7	Rad	Direct	800	2,600	.....	.....	.....	91/98	50.45	7.21	1,056
	867C9HE1, 2 R1820-82	9	Rad	G .5625:1	1,525	2,800	.....	.....	.....	115/145	55.74	7.21	1,445
	871C7BA1[1] R1300-3	7	Rad	Direct	800	2,600	.....	.....	.....	91/98	50.45	7.21	1,080
	872TC18DA1 R3350-34	18	Rad	G .4375:1	3,250	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,457
	878TC18EA1 R3350-32a	18	Rad	G .4375:1	3,700	2,900	.....	.....	.....	115/145	56.6	6.466[4]	3,458
	895C9HE1 R1820-84	9	Rad	Direct	1,525	2,800	.....	.....	.....	115/145	55.74	7.21	1,405
	896C9HD1 R1820-86	9	Rad	G .666:1	1,425	2,700	.....	.....	.....	100/130	55.27	7.21[2]	1,385
	923TC18DA1 R3350-91	18	Rad	G .4375:1	3,250	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,620
	932TC18EA2	18	Rad	G .355:1	3,400	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,708
	957C7BA1	7	Rad	G .5625:1	800	2,600	490	2,130	10,500	91/98	50.45	7.21	1,065
	968C9HE1	9	Rad	G .5625:1	1,475	2,800	890	2,400	13,000	100/130	54.95	7.21	1,390
	972TC18DA1, 2[6]	18	Rad	G .4375:1	3,250	2,900	1,910	2,400	11,400	115/145	56.6	6.46[4]	3,514
	975C18CB1	18	Rad	G .4375:1	2,800	2,900	1,600	2,400	12,500	115/145	56.6	6.46[4]	3,029
	976C9HE1	9	Rad	G .5625:1	1,535	2,800	890	2,400	12,200	100/130	55.75	7.21[2]	1,460
	977C9HD1[1]	9	Rad	Direct	1,425	2,700	.....	.....	.....	100/130	55.25	7.21[2]	1,349
	982C9HE1	9	Rad	G .5625:1	1,525	2,800	.....	.....	.....	115/145	55.75	7.21	1,455
	987C9HD1	9	Rad	G .666:1	1,425	2,700	975	2,500	18,300	100/130	54.95	7.21[2]	1,371
	988TC18EA-1[7]	18	Rad	G .4375:1	3,400	2,900	1,910	2,400	13,500	115/145	56.59	6.46[4]	3,699
	988TC18EA2	18	Rad	G .355:1	3,400	2,900	1,910	2,400	13,500	115/145	56.59	6.46[4]	3,745
	989C9HE1, 2[1]	9	Rad	Direct	1,525	2,800	.....	.....	.....	115/145	55.74	7.21	1,405

G —Geared
Ho —Horizontally opposed.
Rad —Radial.
SL —Sea level.
Vo —Vertically opposed.

[1] For helicopter installation.
[2] Or 10.14:1.
[3] Or 8.68:1.
[4] Or 8.67:1.
[5] 856TC18DB2 (R3350-36W) is similar but has takeoff power of 3,250 hp. and dry gross weight of 3,445 lb. 868TC18DB1 (R3350-55) and 868TC18DB2 (R3350-59) is similar to -30WA but weighs 3,438 lb. dry. Some have manifold absolute pressure regulator.
[6] DA3 is identical to DA1 except for incorporation of increased capacity main bearings, improved pistons and improved PRT cooling air impellers. DA4 identical to DA2 except for differences as listed for DA3 and DA1 engines.
[7] EA3 is same as EA1 except for modified baffles and fuel injection line routing. EA5 is same as EA4 except for differences listed for EA3 and EA1. EA5 is similar to EA2 except for improvements which permit increased cruise power.

• SPECIFICATIONS

U.S. Personal and Business Aircraft

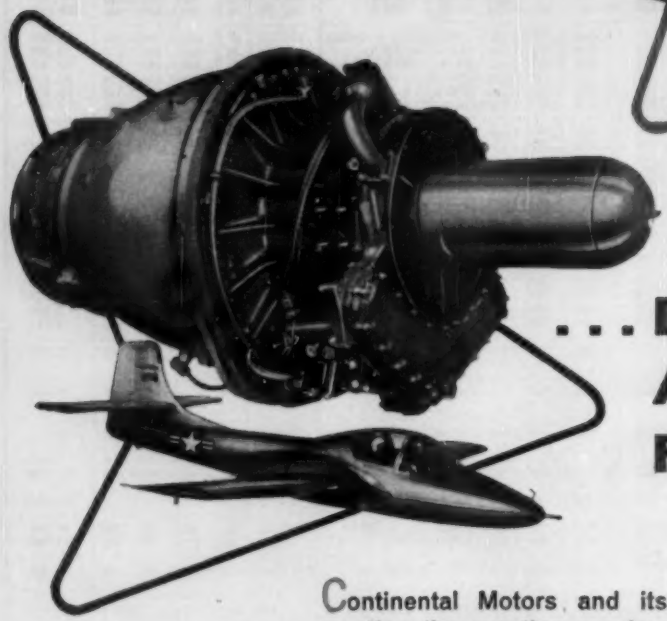
Manufacturer and Address	Designation	No. Seats	Wing Span	Length	Height	Wing Area (sq. ft.)	Empty Weight (lb.)	Gross Weight (lb.)	Powerplant Number, make, model and max. rating, ea.	Max. Speed (mph)	Cruising Speed (mph)	Stalling Speed (mph)	Range (mi.)	Service Ceiling (ft.)	Price
Aero Design & Engr'g. Co. *Bethany, Okla.*	560 Commander	7	40′	35′ 1″	14′ 6″	255	3,850	6,000	2 Lyc. O540-A1A @ 250 hp.	158	318	70	1,450	1,350	1,100	64,750
	560E Commander	7	40′	35′ 5″	14′ 6″	255	4,406	6,300	2 Lyc. GO480-C1B6 @ 295 hp.	233	270	70	2,040	1,485	1,600	89,500
	680 Commander Super	7	44′	35′ 5″	14′ 9″	242	4,485	7,000	2 Lyc. GSO480-B1A6 @ 340 hp.	233	270	70	1,500	1,605	1,450	78,400
	680E Commander Super	7	49′	35′ 5″	14′ 9″	256	4,475	7,500	2 Lyc. GSO480-B1A6 @ 340 hp.	233	255	70	1,500	1,605	1,400	94,500
	720 Alti-Cruiser [1]	7	44′	35′ 5″	14′ 9″	242	.....	7,000	2 Lyc. GSO480-B1A6 @ 340 hp.	233	270	70	1,500	1,605	1,450	182,750
Aircraft Marine Engr'g Corp. *Van Nuys, Calif.*	A-1 Auser	9	46′	39′	11′	260	4,100	9,000	2 Con. 420-M @ 1,200 lb. t.	480	460	43	650	650	1,650	199,000
	A-2 Avocet	20	72′	60′	19′	650	10,250	24,000	4 Con. 420-M @ 1,500 lb. t.	1,600	450	48	2,000	1,500	2,900	500,000
Beech Aircraft Corp. *Wichita, Kans.*	Super 18 (E18S)	8	49′ 8″	35′ 2″	9′ 6″	361	6,050	9,300	2 P&W R985-AN14B @ 450 hp.	275	234	87	1,800	1,700	1,626	122,500
	Bonanza K35	4	32′ 10″	25′ 2″	6′ 6″	178	1,832	2,950	1 Con. IO470-C @ 250 hp.	49	210	59	670	400	1,245	25,300
	Twin-Bonanza D50B	6	45′ 3″	31′ 6″	11′ 4″	277	4,090	6,300	2 Lyc. GO480-G2D6 @ 295 hp.	134	214	71	1,260	1,455	1,650	90,500
	Twin-Bonanza G50	6	45′ 3″	31′ 6″	11′ 4″	277	4,443	7,150	2 Lyc. IGSO480-A1A6 @ 340 hp.	180	240	85	1,310	1,840	1,720	92,500
	Travel Air 95	4	37′ 10″	25′ 4″	9′ 6″	194	2,570	4,000	2 Lyc. O360-A1A @ 180 hp.	84	210	70	1,025	950	1,410	51,500
	MS 760 [1]	4	33′ 3″	33′	8′ 6″	194	4,250	7,800	2 Turbomeca IIC @ 852 lb. t.	370	415	92	4,135	4,400	950	210,000
Call Air *Afton, Wy.*	150	2	35′ 5″	23′ 9″	10′	185	1,020	2,150	1 Lyc. O320-A2A @ 150 hp.	25	110	43	750	400	325	.....
	180	2	35′ 5″	24′	7′ 10″	186	1,170	2,350	1 Lyc. O360-A1A @ 180 hp.	40	115	46	750	400	.....	.....
Cessna Aircraft Co. *Wichita, Kans.*	150	2	33′ 4″	21′	6′ 11″	160	962	1,800	1 Con. O200-A @ 100 hp.	26	124	50	1,205	1,055	630	6,995
	172	4	36′	25′	8′ 6″	175	1,280	2,200	1 Con. O300-A @ 145 hp.	42	135	.....	.....	.....	620	9,250
	175	4	36′	24′	8′ 6″	175	1,312	2,350	1 Con. GO300-A @ 175 hp.	52	147	.....	.....	.....	720	11,250
	180	4	36′	26′	8′ 6″	175	1,326	2,650	1 Con. O470-K @ 230 hp.	65	170	.....	.....	.....	845	14,250
	182	4	36′	26′	8′ 6″	175	1,343	2,650	1 Con. O470-L @ 230 hp.	65	167	.....	.....	.....	835	14,600
	Skylane	4	36′	26′	8′ 6″	175	1,394	2,650	1 Con. O470-L @ 230 hp.	65	170	.....	.....	.....	845	17,095
	310C	5	36′	27′	10′ 6″	175	3,020	4,830	2 Con. IO470-D @ 260 hp.	100	242	.....	.....	.....	1,110	39,950
Champion Aircraft, Inc. *Osceola, Wisc.*	7EC Traveler	2	33′ 2″	21′ 8″	5′ 2″	170	800	1,450	1 Con. C90-12F @ 95 hp.	29	115	38	500	350	500	5,210
	7FC Tri-Traveler	2	33′ 2″	21′ 8″	7′ 2″	170	930	1,450	1 Con. C90-12F @ 95 hp.	29	115	44	500	350	500	6,210
	7GC Sky-Trac	2	33′	21′ 11″	6′ 2″	170	930	1,650	1 Lyc. O290-D2B @ 140 hp.	39	135	40	300	350	660	6,550
	7HC DX'er	3	33′	21′ 11″	7′	164	1,000	1,650	1 Lyc. O290-D2B @ 140 hp.	39	135	45	350	350	650	6,995
Colonial Aircraft Corp. *Sanford, Me.*	C-2 Skimmer IV	4	34′	23′ 6″	9′	156	1,500	2,350	1 Lyc. O360 @ 180 hp.	40	140	52	.....	.....	800	21,700
Fletcher Aviation Corp. *Rosemead, Calif.*	FU-24 Utility	5	42′	31′ 10″	9′ 4″	294	1,880	3,500	1 Con. O470-N @ 240 hp.	44	130	48	.....	.....	410	24,290
Forney Aircraft *Ft. Collins, Colo.*	F-1 Aircoupe	2	30′	20′ 2″	6′ 3″	143	900	1,400	1 Con. C90 @ 95 hp.	24	130	38	600	600	500	.....
Grumman Aircraft Engr'g. Corp. *Bethpage, N. Y.*	159 Gulfstream [1]	14	78′ 6″	64′	22′ 9″	615	20,434	32,500	2 Rolls-Royce RDa. 7/2 @ 2,105 eshp.	1,304	350	94	3,980	1,900	2,050	845,000 [2]
	164 Crop Duster	1	35′ 8″	24′ 4″	10′ 9″	326	2,179	3,600	1 Con. W670 @ 220 hp.	24	110	.....	.....	.....	.....	18,500*
Helio Aircraft Corp. *Norwood, Mass.*	H-391B Courier	5	39′	30′	8′ 10″	231	1,920	3,000	1 Lyc. GO435-C2B @ 260 hp.	60	169	30	495	495	750	29,600
	H-395 Super Courier	5	39′	30′	8′ 10″	231	2,012	3,000	1 Lyc. GO480-G1D6 @ 295 hp.	60	176	30	475	475	842	33,980
Lockheed Aircraft Corp. *Marietta, Ga.*	329 Jetstar [1]	12	53′ 8″	60′ 5″	20′ 6″	521	16,920	38,920	4 P&W JT-12 @ 3,000 lb. t.	2,676	573	132	6,300	5,600	2,810	1,13,000 [3]
McDonnell Aircraft Corp. *St. Louis, Mo.*	119 [1]	12	87′ 7″	66′ 6″	23′ 8″	550	.....	40,928	4 P&W JT-12 @ 3,000 lb. t.	.....	565 [4]	108	.....	.....	2,335 [5]	.....
Mooney Aircraft, Inc. *Kerrville, Tex.*	Mark 20	4	35′	23′ 2″	8′ 5″	167	1,480	.....	1 Lyc. O320 @ 150 hp.	80	177	57	.....	.....	1,000	13,850
	Mark 20-A	4	35′	23′	8′ 5″	167	1,450	2,480	1 Lyc. O360 @ 180 hp.	99	195	57	.....	.....	1,000	14,850
	Mark 22	4	35′	23′	8′ 5″	167	1,950	3,250	2 Lyc. O320 @ 150 hp.	100	220	.....	.....	.....	1,400	27,500
Piper Aircraft Corp. *Lock Haven, Pa.*	PA-18 "95"	2	35′ 3″	22′ 5″	6′ 7″	178.5	800	1,800	1 Con. C90 @ 90 hp.	18	112	43 [6]	780	800	390	5,850
	PA-18 "150"	2	35′ 3″	22′ 5″	6′ 7″	178.5	930	1,750	1 Lyc. O320 @ 150 hp.	36	130	43 [6]	500	725	490	7,450
	PA-18-A Super Cub	1	35′ 3″	22′ 5″	6′ 7″	178.5	1,060	2,070	1 Lyc. O320 @ 150 hp.	36	105	45 [6]	950	875	390	7,695
	PA-22 Caribbean	4	29′ 4″	20′ 7″	6′ 4″	147.5	1,100	2,000	1 Lyc. O320 @ 150 hp.	36	130	49 [6]	1,220	500	500 [5]	8,395
	PA-22 "160" Tri-Pacer	4	29′ 4″	20′ 7″	6′ 4″	147.5	1,110	2,000	1 Lyc. O320-B @ 160 hp.	36	141	49 [6]	900	.....	536	8,890
	PA-23 "160" Apache	3-5	37′	27′	9′ 6″	204	2,230	3,500	2 Lyc. O320-B @ 160 hp.	72	163	59 [6]	900	670	533	36,990
	PA-24 "180" Comanche	4	36′	24′ 8″	7′ 4″	178	1,475	2,550	1 Lyc. O360-A1A @ 180 hp.	50	167	58 [6]	750	600	920	14,995
	PA-24 "250" Comanche	4	36′	24′ 11″	7′ 4″	178	1,600	2,800	1 Lyc. O540-A1A @ 250 hp.	60	190	64 [6]	750	650	1,100	18,995
	PA-25 Pawnee	1	.....	.....	.....	.....	.....	2,300	1 Lyc. O320 @ 150 hp.	.....	.....	.....	.....	.....	.....	9,000*
	Aztec	3-5	.....	.....	.....	.....	.....	.....	2 Lyc. O540 @ 250 hp.	.....	.....	.....	.....	.....	.....	.....
Rawdon Bros. Aircraft, Inc. *Wichita, Kans.*	T-1, T-18D	1-2	33′ 4″	24′ 2″	7′ 3″	.....	1,300	1,900	1 Lyc. O320 @ 150 hp.	.....	136	50	.....	.....	500	.....
Schweizer Aircraft Corp. *Elmira, N. Y.*	1-30	1	40′	20′ 3″	6′ 2″	160	700	1,100	1 Con. A65-12 @ 65 hp.	.....	110	.....	.....	.....	350	.....
Stits Aircraft *Riverside, Calif.*	SA9A Skycoupe	2	28′ 4″	17′ 6″	.....	125	695	1,250	1 Con. C90-12F @ 95 hp.	24	145	.....	350	400	500	4,500
Taylorcraft, Inc. *Conway, Pa.*	Zephyr	4	34′ 8″	24′ 4″	7′ 2″	179	1,700	2,750	1 Con. O470-J @ 225 hp.	66	160	65	450	700	750	.....
	Topper	1	34′ 8″	24′ 4″	7′ 2″	179	1,635	2,750	1 Con. O470-J @ 225 hp.	48	115	70	900	900	400	.....
Transland Aircraft *Torrance, Calif.*	Ag-2	1	42′	28′ 5″	9′ 8″	321	3,382	6,000	1 P&W R1340 @ 600 hp.	125	144	51	900	600	.....	28,500

Numerous business and utility aircraft types serve in armed forces of U.S. and friendly foreign governments. Examples:
Aero Commander — L-26B 560A (including President Eisenhower's airplane).
Aero Commander L-26C — Model 680 Super.
Aero Commander RL-26D — L-26C with side-looking radar.
Beech L-23D — Model G50 Twin-Bonanza.
Beech L-23E — Model D50A Twin-Bonanza.
Cessna U-3A — Model 310C.
Helio L-28A — Model H-395 Super Courier.
All. — Allison.
Con. — Continental.
Lyc. — Lycoming.
P&W — Pratt & Whitney Aircraft.

[1] Pressurized cabin.
[2] Minus custom interior, communications-navigation equipment.
[3] Complete, including auxiliary tanks.
[4] Maximum cruise speed.
[5] Normal still-air range; internal auxiliary tanks boost this to 3,000 mi.
[6] Stall speed.
* — Approximate.

Landing and takeoff distance data supplied by manufacturers, in some cases, appear to be only rolling distance on the ground.

PISTON OR TURBINE



. . . DEPENDABLE AIRCRAFT POWER

Continental Motors and its CAE subsidiary are successfully meeting the exacting requirements of the Military for dependable aircraft power. Continental engines—piston or turbine—power not only the familiar L-19 liaison plane, but the standard jet trainers as well. Engine-building experience dating from 1902 assures the "rightness" of the engines with the Continental nameplate.

FOR TURBINE INFORMATION, ADDRESS:

CONTINENTAL AVIATION AND ENGINEERING CORP.

12700 KERCHEVAL AVENUE, DETROIT 15, MICHIGAN

FOR RECIPROCATING ENGINE INFORMATION, ADDRESS:

Continental Motors Corporation

AIRCRAFT ENGINE DIVISION

205 MARKET STREET, MUSKEGON, MICHIGAN

U.S. Gas Turbine Engines

Manufacturer and Address	Designation	Type	No. of compressor stages: axial, centrifugal	No. of turbine stages	No. of combustors	Max. power at S. L.	Specific fuel consumption at max. power; lb./hr./lb. t. or eshp.	Compression ratio at max. rpm.	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less subsists, lb.	Remarks
Avco Manufacturing Corp. **Lycoming Division** *Stratford, Conn.*	T53-L-1	ACS	5, 1	1	..	860 shp.	0.77	6	23	47.6	480	In production.
	T53-L-3	ACP	5, 1	1	..	960 shp.	0.687	6	23	58.9	520	Qualification Apr. '59.
	T53-L-5	ACS	5, 1	1	..	960 shp.	0.696	6	23	47.6	470	Qualification late '59.
	T55-L-1	ACP	7, 1	1	..	1,600 shp.	0.679	6.3	24.25	58.8	695	
	T55-L-3	ACS	7, 1	1	..	1,850 shp.	0.677	6.3	24.25	44	600	50-hr. test early '59.
Boeing Airplane Co. *Seattle, Wash.*	502-2	CS	1	1+1	2	400 eshp.	0.72	.....	23.7	57.25	350	Helicopter type.
	502-10C	CS	1	2	2	240 eshp.	1	4.1	24	48.4	330	
	502-10F	CS	1	2	2	300 eshp.	1	4.47	24	48.4	300	Radioplane RP-77.
	514-2	CFG	1	1	1	388 air hp. + 100 shp.	.....	5.5	29	41	325	
	502-11B	CFG	2	2	2	210 air hp.	.....	3.5	28.5	46.1	350	
	T60	.....	.....	.....	.....	400 hp.	.....	.....	.....	.....	320	Helicopter type.
Continental Aviation & Engr'g. Corp. *Detroit, Mich.*	J69-T-9; T-2	CFJ	1	1	1	920 lb. t.	1.12	.....	.....	50	364	Cessna T-37A, Temco TT-1.
	J69-T-19B	CFJ	1	1	1	1,060 lb. t.	1.27	3.8	22.3	43.3	312	Ryan Q-2A
	J69-T-25	CFJ	1	1	1	1,025 lb. t.	1.14	.....	24.9	50	364	Cessna T-37A.
	J69-T-29	ACJ	2	1	1	1,700 lb. t.	1.10	.....	.....	48.3	335	Ryan Q-2C.
	T51-T-3	CFP	1	2	1	425 eshp.	0.97	.....	.....	36	236	
	Model 217	CFP	2	3	1	425 eshp.	0.64	5.7	18	71.5[1]	245	Potential; 500-600 hp.
	Model 217-1	ACS	2	3	1	400 hp.	0.68	5.7	18	53.5	235	
	Model 324	ACJ	2	2	1	550 lb. t.	0.97	.....	16.4	56.8	214	
	Model 320	CFJ	1	1	1	360 lb. t.	1.23	.....	16.5	35.5	158	
	Model 141	CFJ	1	1	1	191 air hp.	.....	.....	.....	.....	197	For pressure-jet helicopter.
	J87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Curtiss-Wright Corp. **Wright Aeronautical Division** *Wood-Ridge, N. J.*	J65-W-5	AFJ	13	2	1	7,200 lb. t.	.....	.....	37.5	100	2,750	
	J65-W-7	AFJ	13	2	1	7,800 lb. t.	.....	.....	37.5	115	2,795	
	J65-W-16-16A	AFJ	13	2	1	7,700 lb. t.	.....	.....	37.5	113	2,742	
	J65-W-18	AFJ	13	2	1	10,000 lb. t.	.....	.....	37.5	181	3,455	
	TJ38 Zephyr	AFJ	12	2	8	12,500 lb. t.	.718	10.5	41	121	3,900	Has sound suppressor & thrust reverser.
	TJ34-AB1	AFJ	7	1	1	1,750 lb. t.	1.11	4.0	24.0	66.0	510	
	TP45A1	AFP	12	4	10	7,500 eshp.	.322	10.5	42.0	115.0	3,805	Twin spool compressor.
	J67	AFJ	.....	.....	.....	10,000 lb. t. *	.....	.....	.....	.....	.....	
Fairchild Engine & Airplane Corp. **Fairchild Engine Division** *Deer Park, N. Y.*	J44-R-3	ACJ	1	1	1	1,000 lb. t.	1.55	2.47	24.3	90.4	380	
	J44-R-20, -20B, -24	ACJ	1	1	1	1,085 lb. t.	1.65	2.5	24	80	348	
	J44-R-26	ACJ	1	1	1	1,100 lb. t.	1.30	3.25	22.3	92	365	
	FT-101E	ACJ	1	1	1	1,000 lb. t.	1.55	2.47	24.3	90.4	380	Certificated civil J44.
General Electric Co. **Aircraft Gas Turbine Division** *Evendale, Ohio*	J79	AFJ	17	3	10	15,000 lb. t. *	.....	12	36	204	3,200*	Growth models in production
	CJ-805-3	AFJ	17	3	10	15,000 lb. t.*	.....	12	32	110	2,800*	Convair 660.
	CJ-805-21	BPJ	17	3	10	15,000 lb. t.*	.....	12[2]	35	144	3,750*	Aft fan; Convair 600.
	J93	AFJ	.....	.....	..	35,000 lb. t.*	.....	.....	.....	.....	.....	B-70, F-108.
	Nuclear	.....	.....	.....	..	.....	.....	.....	.....	.....	.....	Lockheed WS-125 bomber.
Small Aircraft Engine Dept. *Lynn, Mass*	T58-GE-6	AFS	10	2	..	1,025 shp.	0.654	8.3	.....	.....	367*	S-61, S-62, HU2K-1.
	J85	AFJ	.....	.....	..	2,500 *	.....	.....	.....	.....	.....	Jetstar, T-39.
	T64	AFS	.....	.....	..	2,600 shp.class	.....	.....	.....	.....	.....	
General Motors Corp. **Allison Division** *Indianapolis, Ind.*	J33-A-41	CFJ	1	1	14	5,100 lb. t.	1.14	4.35	52	156	1,530	
	J71-A-2	AFJ	16	3	..	10,000 lb. t.	.....	.....	43	285	4,017	
	T56-A-1	AFP	14	4	6	3,750 eshp.	0.54	9.25	40	145	1,645	
	T56-A-7	AFP	14	4	6	4,050 eshp.	.....	.....	.....	.....	.....	
	T56-A-8	AFP	14	4	6	4,050 eshp.	.....	.....	.....	.....	.....	
	T56-A-9	AFP	14	4	6	3,750 eshp.	.....	.....	.....	.....	.....	
	T56-A-10W	AFP	14	4	6	4,585 eshp.	.....	.....	.....	.....	.....	Water/alcohol injection.
	501-D13	AFP	14	4	6	3,750 eshp.	0.54	9.25	36	145	1,645	Lockheed Electra.
	550	AFP	.....	.....	..	5,500 eshp.	.....	.....	.....	.....	.....	Split compressor.
	J89	.....	.....	.....	..	25,000 lb. t.	.....	.....	.....	.....	.....	
	T63 turboprop	ACP	7, 1	...	1	250 eshp.	0.70	.....	19.5	38.5	110	Single-stage gas producer, two-stage power turbine.
	T63 turboshaft	ACP	7, 1	...	1	250 hp.	0.70	.....	19.5	34.0	95	Max. width 15.8 in.
Solar Aircraft Co. *San Diego, Calif.*	T62	.....	1	1	1	78.4 eshp.	1.18	3.42	15.6	23.8	48.5	Single-shaft, constant-speed; T66 is variable speed.
United Aircraft Corp. **Pratt & Whitney Aircraft Division** *E. Hartford, Conn.*	T34-P-7W	AFP	13	3	8	9,000 eshp.	0.63	6.7	33.75	156.8	2,670	PT2G-4
	T34-P-9W	AFP	13	3	8	7,500 eshp.	0.55	6.7	34.06	155.12	2,870	PT2G-6
	J48-P-8	CFJ	1	...	9	7,250 lb. t.	1.14	4	50.5	109.75	2,080	JT7H.
	JT3C-6	AFJ	16	3	8	13,000 lb. t.	0.90	12	38.88	.....	4,234	Civil J57.
	JT3C-7	AFJ	16	3	8	12,000 lb. t.	0.785	13	38.88	.....	3,995	Civil J57.
	JT3D-1	AFF	13[3]	3	8	16,000 lb. t.	0.61	.....	53	.....	4,025	Civil J57 turbofan.
	J57-P-42W	AFJ	16	3	8	13,750 lb. t.	0.95	13	38.6	167.33	3,840	JT3C-2.
	J57-P-16, -55	AFJ	16	3	8	15,900 lb. t.	2.30	13	39.6	250.84	4,750	JT3C-21.
	JT12A-3	AFJ	9	2	8	2,900 lb. t.	0.93	.....	21.9	76	430	Civil J60.
	J60-P	AFJ	9	2	8	2,900 lb. t.	0.93	.....	21.9	76	430	JT12A-1.
	J60-P	AFJ	9	2	8	3,900 lb. t.	2.30	.....	21.9	126	645	JT12A-30.
	J58	AFJ	.....	.....	..	30,000+ lb. t.	.....	.....	.....	.....	.....	Split compressor; civil version is JT9.
	J52	.....	.....	.....	..	7,500 lb. t.	.....	.....	.....	.....	.....	
	J91	.....	.....	.....	..	.....	.....	.....	.....	.....	.....	Aircraft nuclear engine.
Westinghouse Electric Corp. **Aviation Gas Turbine Division** *Kansas City, Mo.*	J34-WE-34	AFJ	11	2	1	3,250 lb. t.	1.06	4.1	27	122	1,194	
	J34-WE-36	AFJ	11	2	1	3,400 lb. t.	1.04	4.1	27	112	1,207	
	J34-WE-46	AFJ	11	2	1	3,400 lb. t.	1.06	4.1	27	112	1,242	In T2J-1.
	J54-WE-2	AFJ	.....	.....	..	6,700 lb. t.	.....	.....	.....	.....	.....	High-altitude engine.
	XJ81-WE-3	AFJ	.....	.....	..	1,800 lb. t.	.....	.....	.....	.....	.....	

Abbreviations: *—Approximate
ACJ—Axial-centrifugal turbojet
ACS—Axial-centrifugal shaft turbine
AFP—Axial-flow turboprop
CFJ—Centrifugal-flow turbojet
CS—Centrifugal shaft turbine
Eshp.—Equivalent shaft horsepower
Lb. t.—Pounds thrust
Shp.—Shaft horsepower

Leading Foreign Aircraft, Military and Civil

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Over-all wingspan, ft.	Over-all length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
ARGENTINA													
Fabrica Militar de Aviones (Instituto Aerotecnico) *Cordoba*	I.A. 35	Huanquero	Multi	3	8	64′ 3″	45′ 10″	15′ 5″	455	7,760	13,700	2 I.A. 19 R El Indio @ 620 hp.	225
	I.A. 37	.....	Research	1	0	32′ 9″	38′	11′ 9″	516	6,180	9,900	1 R-R Derwent 5 @ 3,900 lb. t.	500
	I.A. 45	.....	Personal	1	3–4	44′ 6″	29′	9′ 2″	205	2,426	3,670	2 Lyc. O-320 @ 150 hp.	178
	I.A. 46	.....	Utility	1	2	38′ 7″	24′ 11″	7′ 3″	194	1,213	2,204	1 Lyc. O-320 @ 150 hp.	121
AUSTRALIA													
Commonwealth Aircraft Corp Pty., Ltd. *Lorimer Street, Port Melbourne, Victoria*	C.A. 25	Winjeel	Trainer	2	0	38′ 9″	28′	9′	249	3,289	4,235	1 P&W R985-AN 2 @ 450 hp.	187
	C.A. 27	Sabre Mk. 32	Fighter	1	0	37′ 1″	37′ 6″	14′ 8″	302	11,000	20,000	1 R-R Avon 26 @ 7,500 lb. t.	700
	C.A. 28	Ceres	Agricultural	1	0	47′	30′ 3″	9′	312	4,060	7,000	1 P&W Wasp S3H1-G @ 600 hp.	140
Government Aircraft Factories *Fishermen's Bend, Melbourne, Victoria*	.....	Canberra 20	Bomber	2	0	64′	65′ 6″	15′ 6″	960	.....	51,000	2 R-R Avon Mk. 109	...
	.....	Jindivik Mk. 2	Drone	0	0	19′	23′ 4″	.....	76	1,750	2,800	1 B-S Viper A8V3	575
BELGIUM													
Avions Fairey S.A. *Gosselies*	.....	Tipsy Junior Mk. VI	Personal	1	0	23′	18′ 9½″	4′ 6″	113	470	770	1 Con. @ 65 hp.	107
	T.66	Tipsy Nipper	Personal	1	0	19′ 8″	14′ 9″	5′ 3″	81	360	660	1 Volkswagen @ 30 hp.	75
CANADA													
Avro Aircraft Ltd. *Box 4004, Terminal "A", Toronto, Ontario*	CF-100 Mk. 5	.....	Interceptor	2	0	60′ 10″	54′ 2″	14′ 6″	591	.....	33,600	2 Orenda 11 @ 7,000 lb. t.	...
	CF-105	Arrow	AW Fighter	2	0	50′	77′ 9″	21′ 3″	1,550	.....	70,000[2]	2 Orenda Iroquois @ 20,000 lb. t.	M=2
Canadair Ltd. *P.O. Box 6087, Montreal, Quebec*	.....	Sabre 6	Fighter	1	0	37′ 1½″	37′ 6″	14′ 9″	.....	.....	.....	1 Orenda 14 @ 7,200 lb. t.	700
	CP-107	Argus	Anti-Sub.	15	0	142′ 3½″	128′ 3″	36′ 8½″	2,075	.....	145,000	4 Wright R-3350@3,700 hp.	290
	T-33A	Silver Star	Trainer	2	0	42′ 5″	37′ 8″	11′ 8″	.....	.....	.....	1 R-R Nene 10 @ 5,100 lb. t.	...
	CL-41	Canadair Trainer	Trainer	1	1	36′ 4″	31′ 11″	9′	220	4,100	6,800	1 P&W JTC-12A / 2 @ 2,400 lb. t.	474
	CC-106	.....	Transport	5	134	142′ 4″	136′ 9″	38′ 11″	2,075	91,607	205,000	4 R-R Tyne 12 @ 5,730 eshp.	...
	CC-109	.....	Transport	3	40	105′ 4″	81′ 6″	28′ 3½″	920	36,742	57,500	2 Napier Eland 506 @ 3,500 eshp.	...
	CL-44D-2	.....	Cargo	4	...	142′ 4″	136′ 8″	38′ 11″	2,075	90,294	205,000	4 R-R Tyne 12 @ 5,730 eshp.	405
	CL-44D-3	.....	Pass./Cargo	4	167	142′ 4″	136′ 8″	38′ 11″	2,075	104,340	205,000	4 R-R Tyne 12 @ 5,730 eshp.	405
	540	.....	Transport	2	48–58	105′ 4″	79′ 2″	28′ 3½″	920	33,822	53,200	2 Napier Eland 506 @ 3,500 eshp.	335
The de Havilland Aircraft of Canada, Ltd. *Station "L", Toronto, Ont.*	DHC-2	Beaver	Transport	1–2	5–6	48′	30′ 4″	10′ 7″	250	2,951	5,100	1 DH @ 480 hp.	...
	DHC-3	Otter	Transport	1–2	9–10	58′	42′	15′	375	4,368	8,000	1 DH @ 600 hp.	...
	DHC-4	Caribou	Transport	2	27–30	95′	68′	30′	920	14,500	26,000	2 DH @ 5,800 lb. t.	...
FRANCE													
Avions Paul Aubert *6, Square Claude Debussy, Paris (17)*	PA-204	Super Cigale	Personal	1	3	32′ 9″	24′ 7″	7′ 10″	139	1,408	2,755	1 Lyc. @ 180 hp.	168
Societe Boisavia *11, Rue Pierre Brossolette, Ivry-sur-Seine*	B.605	Mercury	Personal	1	3	37′ 6″	23′ 6″	7′ 6″	194	1,430	2,575	1 SNECMA 4LO2 @ 170 hp.	155
	B.260	Anjou	Personal	1	4	42′ 8″	23′ 7″	9′ 10″	231	2,866	4,410	2 SNECMA 4LO2 @ 170 hp.	186
S. A. des Ateliers d'Aviation Louis Breguet *24, Rue Georges Bizet, Paris (XVIe)*	1001	Taon	Fighter	1	0	.....	37′ 1″	12′ 1½″	158	.....	11,025	1 B-S Orpheus 3 @ 4,850 lb.t.	...
	1100	.....	Fighter	1	0	28′ 7″	41′	14′ 3″	215	.....	13,230	2 Turb. Gabizo	M>1
	1050	Alize	Anti-Sub.	3	0	50′ 2″	45′	17′	387.5	.....	17,640	1 R-R Dart R. Da.7 @ 2,000 eshp.	205
	940	Integral	Pass./Cargo	...	21	57′ 5″	39′ 4″	.....	.....	.....	14,330	4 Turb. Turmo @ 400 hp.	236
	763	Deux Ponts	Transport	3	107	140′ 8″	94′ 11″	31′ 4″	1,965	68,150	113,500	4 P&W CA-18 @ 2,400 hp.	272
Generale Aeronautique Marcel Dassault *78, Quai Carnot, Saint Cloud, (Seine-et-Oise)*	.....	Mediterranee	Transport	...	7	.....	.....	.....	.....	.....	.....	2 B-S Viper @ 3,000 lb. t.	700*
	M.IV A	Mystere IV A	Fighter-Bomber	1	0	36′ 8″	42′ 4″	14′ 9″	344	12,492	17,000	1 RR. Verdon @ 7,700 lb. t.	M<1
	M.IV B	Mystere IV B	Fighter-Bomber	1	0	36′ 5½″	43′ 11½″	14′ 5″	344	.....	.....	1 R-R Avon Ra. 7R	...
	SM.B. 2	Super Mystere	Fighter-Bomber	1	0	34′ 4″	46′	14′ 11″	375	18,300	20,000	1 SNECMA Atar 101 G-2 @ 10,000 lb. t.	M=1
	Etendard IV-M	Etendard IV-M	Fighter	1	0	31′	.....	.....	305	.....	17,500	1 SNECMA Atar 8 @ 10,000 lb. t.	M=1
	Etendard IV	Etendard IV	Fighter-Bomber	1	0	27′	.....	.....	275	.....	16,000	1 B-S Orpheus 12 @ 8,000 lb. t.	M=1
	Etendard VI	Etendard VI	Fighter	1	0	29′ 11″	29′ 5″	.....	.....	.....	.....	1 B-S Orpheus BOr.3 @ 4,850 lb. t.	...
	Mirage III-A	Mirage III-A	Interceptor	1	0	.....	.....	.....	.....	.....	17,000	1 SNECMA Atar 9 @ 13,800 lb. t.+1 SEPR rocket	M>2
Hurel-Dubois *Route de Verrieres a Meudon, Villacoublay, (Seine-et-Oise)*	H.D. 321	.....	Transport	3	44	148′ 7½″	77′ 4″	28′ 7½″	1,076	24,498	41,200	2 Wright 982C9HE1 @ 1,525 hp.	306
	H.D. 34	.....	Photo	7	0	148′ 7½″	77′ 6″	28′ 7½″	1,076	26,300	42,000	2 Wright 982C9HE2 @ 1,475 hp.	306

Al. — Alvis
AW — All-Weather
Bl. — Blackburn & General
B-S — Bristol-Siddeley (Alliance of Bristol Aero-Engines and Armstrong Siddeley Motors)
Con. — Continental
DH — de Havilland
ENMA — Empresa Nacional de Motores de Aviacion S.A.
GE — General Electric
H.S. — Hispano-Suiza
I.A. — Fabrica Militar de Aviones (Instituto Aerotecnico)
Lyc. — Lycoming
P&W — Pratt & Whitney
R-R — Rolls-Royce
SEPR — Societe d'Etude de la Propulsion par Reaction
SNECMA — Societe National d'Etude et de Construction de Moteurs d'Aviation
Sven. — Svenska Flygmotor
Turb. — Turbomeca
VTOL — Vertical Take-Off and Landing
* — Cruise Speed
[1] — Approximately
[2] — Consortium of three firms, de Havilland, Fairey, Hunting, are teamed as Aircraft Manufacturing Co. (Airco) on this project. DH is major partner.

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Over-all wingspan, ft.	Over-all length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Societe des Avions Max Holste *11 Rue Gosset, Reims*	M.H. 250	Super Broussard	Transport	1	17–20	70′ 1″	51′ 10″	20′ 10″	581	8,850	14,903	2 P&W R-1340 Wasp/2 Turbo. Bastan	235
Morane-Saulnier *5 & 5 Rue Volta, Puteaux (Seine)*	MS. 733	Alcyon	Trainer	3	0	37′	31′ 1″	11′ 4″	235	2,810	3,850	1 Potez 6 DO2A @ 240 hp.	184
	MS. 760	Paris	Business	1	3	33′ 9″	32′ 11″	9′ 7″	194	4,409	7,000	2 Turb. Marbore II @ 880 lb. t.	405
	MS. 1500	Epervier	Attack	2	0	42′	34′ 5″	10′ 9″	289	3,530	6,000	1 Turb. Bastan @ 650 eshp.	227
Nord Aviation, Societe Nationale de Constructions Aeronautiques *18 bis Avenue Bosquet, Paris (7)*	Nord 2501	Noratlas	Transport	3	42	107′	72′	10′ 1″	1,063	28,600	48,400	2 SNECMA Hercules @ 2,040 hp.	275
	Nord 3202	.....	Trainer	2	0	32′ 11½″	26′ 2½″	10′ 3″	177.5	1,813	2,498	1 Potez 4.D-32 @ 240 hp.	161
	Nord 1405	Gerfaut II	Fighter	1	0	24′ 7″	32′ 6″	13′ 6″	282	8,038	10,252	1 SNECMA Atar 101G @ 9,700 lb. t.	M=1.3
	Nord 1500	Griffon II	Interceptor	1	0	26′ 7″	47′ 6½″	16′ 5″	344.5	.....	14,550	1 SNECMA Atar 101E3+1 Nord ramjet	930
	Nord 3400	.....	Liaison	1	1	41′ 9″	27′ 6″	10′ 2″	209.9	2,028	2,970	1 Potez 4.D-30 @ 240 hp.	124*
Piel-Aviation S.A. *884, Avenue Jean-Jaures, Le Drancy (Seine)*	C.P. 301	Emeraude	Personal	1	1	20′ 3½″	20′ 11½″	5′ 10″	116.7	753	1,345	1 Con. @ 90 hp.	143
Potez Air-Fouga *90, Rue Miromesnil, Paris (8)*	C.M. 170R	Magister	Trainer	2	0	37′ 8″	33′	9′ 2″	186.1	4,740	6,614	2 Turb. Marbore IIA @ 880 lb. t.	455
	C.M. 175	Esquif	Trainer	2	0	37′ 8″	33′	9′ 8″	186.1	5,180	7,055	2 Turb. Marbore 11B @ 880 lb. t.	403
	Potez 75	.....	Attack	2	0	43′	30′	8′ 10″	.....	3,891	5,578	1 Potez 8.D-32 @ 520 hp.	171
Societe Industrielle pour l'Aeronautique *178, Avenue de Neuilly, Neuilly, (Seine)*	S.1100	.....	Liaison	3	0	48′ 2½″	37′	12′ 3½″	.....	8,800	13,640	2 P&W R-1340 @ 610 hp.	227
SNECMA *150 Boulevard Haussman Paris (18)*	C. 450	Coleoptere	VTOL	1	0	.....	23′ 3″	.....	.....	.....	6,000	1 SNECMA Atar 101E.S.V @ 7,700 lb. t.	...
Sud Aviation *37, Boulevard de Montmorency, Paris (XVIe)*	S.E. 210	Caravelle	Transport	3–4	80	112′ 6″	104′ 10″	28′ 6″	1,579	57,970	99,210	2 R-R Avon Mk. 527@10,700 lb. t.	510
	S.O. 4050	Vautour	AW Fighter	2	0	50′	50′	13′	485	22,000	33,000	2 SNECMA Atar 101 E-3 @ 7,700 lb. t.	680
	S.E. 117	Voltigeur	Tac. Support	3	0	58′ 11″	40′ 3″	18′ 7″	448	9,260	14,374	2 Turb. Bastan @ 750 shp.	245
	S-E. 118	Diplomate	Business	2	6–20	58′ 11″	44′ 3½″	20′ 2″	450.5	9,923	15,347	2 Turb. Bastan @ 750 shp.	320
WEST GERMANY													
Ingenieur-Buro Blume *Tausendfensterhaus, Duisberg-Ruhrort*	Blume Bl 502	.....	Personal	1	3	34′ 4″	26′ 5″	7′ 10″	161	1,370	2,340	1 Lyc. 0-320 @ 150 hp.	153
Dornier-Werke GmbH. *Friedrichshafen a.B.*	Do. 27	.....	Multi	1	5	39′ 4½″	31′ 6″	8′ 10″	208.8	2,380	3,750	1 Lyc. GO 480-B1A6 @ 275 hp.	155
Klemm-Flugzeuge GmbH. *Boblingen/Wurtt*	Kl. 107B	.....	Personal	1	2	35′ 6″	27′	7′	157	1,278	2,078	1 Lyc. 0-320-A @ 150 hp.	136
Rhein-Flugzeugbau GmbH. *Arndtstrasse 60, Krefeld-Uerdingen*	RW.3-A3	Multoplane	Personal	1	1	34′ 2″	24′ 4″	8′ 2″	150.7	1,212	1,675	1 Porsche 678/0 @ 65 hp.	132
EAST GERMANY													
Vereinegung Volkseigener Betriebe Flugzeugbau *Pirna/Elbe*	Baade 152	.....	Transport	4–5	48–72	86′ 8″	102′ 8″	31′ 10″	1,485	63,000	102,515	4 Type 014 @ 6,945 lb. t.	572
GREAT BRITAIN													
Sir W. G. Armstrong Whitworth Aircraft, Ltd. *Baginton, Nr. Coventry, Warwickshire*	AW 650	Argosy	Freighterconch	2–3	80	115′	86′ 9″	27′	1,438	45,350	82,000	4 R-R Dart @ 2,100 eshp.	296
	AW 660	Argosy	Transport	4	77	115′	86′ 9″	27′	1,458	50,000	90,000	4 R-R Dart @ 2,410 eshp.	296
	AW 670	Air Ferry	Pass./Cargo	2–3	126	115′	86′ 9″	27′	1,458	47,000	82,000	4 R-R Dart @ 2,100 eshp.	265
Auster Aircraft, Ltd. *Rearsby, Leicester*	Mk. 9	.....	Liaison	3	0	36′ 5″	23′ 8″	8′ 11″	197.6	1,880	2,125	1 Bl. Bombardier @ 180 hp.	127
	B.8	Agricola	Agricultural	1	2	42′	28′ 1″	8′ 4″	254.7	.....	3,810	1 Con. O-470-M @ 240 hp.	127
	J/1U	Workmaster	Agricultural	1	1	36′	23′ 7″	6′ 2″	185	.....	2,550	1 Lyc. O-360-A @ 180 hp.	104
	.....	Atlantic	Business	1	5	.....	.....	.....	.....	.....	.....	1 Con. E0510 @ 305 hp.	135
	J1N	Alpha	Utility	1	2	.....	.....	.....	.....	.....	.....	1 DH Gypsy Major 1 @ 130 hp.	108*
	J5F	Aiglet	Trainer	2	1	32′	23′ 2½″	8′ 3″	164	1,323	2,300	1 DH Gipsy Major 1 @ 130 hp.	127
	J5B	Autocar	Personal	1	3	36′	23′ 2″	7′ 6″	163	1,413	2,400	1 DH Gipsy Major 1 @ 130 hp.	116
	.....	Alpine	Personal	1	2	36′	23′ 2″	7′ 6″	163	.....	.....	1 DH Gipsy Major 10 @ 145 hp.	124
Blackburn and General Aircraft, Ltd. *Brough, Yorkshire*	C. Mk. 1	Beverley	Transport	4	94	162′	99′ 5″	38′ 5″	2,916	82,100	135,000	4 B-S Centaurus 173 @ 2,850 h. p.	238
	N.A. 39	.....	Strike	2	0	.....	.....	.....	.....	.....	.....	2 D-H Gyron Junior @ 7,000 lb. t.	M<1
	B.107A	.....	Transport	.....	.....	166′ 8″	124′	31′	.....	.....	.....	4 R-R Tyne @ 5,000 eshp.	...

Leading Foreign Aircraft, Military and Civil

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Over-all wingspan, ft.	Over-all length, ft.	Maximum height, ft.	Wing Gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Bristol Aircraft Ltd. *Filton House, Bristol*	175	Britannia 100	Transport	9	92	142' 4"	114'	37' 6"	2,075	86,000	155,000	4 B-S Proteus 705 @ 3,500 eshp.	370
	175	Britannia 300	Transport	9	132	142' 4"	124' 3"	37' 6"	2,075	91,250	160,000	4 B-S Proteus 755 @ 4,120 eshp.	400
	175	Britannia 310	Transport	9	132	142' 4"	124' 3"	37' 6"	2,075	87,785	180,000	4 B-S Proteus 765 @ 4,445 eshp.	400
	175	Britannia 250	Pass./Cargo	9	84	142' 4"	124' 3"	37' 6"	2,075	89,405	180,000	4 B-S Proteus 765 @ 4,445 eshp.	400
	175	Britannia 320	Transport	9	139	142' 4"	124' 3"	37' 6"	2,075	92,040	180,000	4 B-S Proteus 765 @ 4,445 eshp.	410
	205	.....	Transport	...	88	.....	.....	.....	.....	.....	.....	4 B-S Orpheus	560*
The de Havilland Aircraft Co. Ltd. *Hatfield Aerodrome, Herts*	D.H. 110	Sea Vixen	AW Fighter	2	0	50'	53' 6"	11'	.....	.....	.....	2 R-R Avon	M>1
	D.H. 104	Dove	Transport	2	8-11	57'	39' 4"	13' 4"	335	5,678	8,800	2 DH Gipsy Queen 70 Mk. 2 @ 380 hp.	200
	D.H. 114	Heron	Transport	2	14-17	71' 6"	48' 6"	18' 7"	499	8,484	13,500	4 DH Gipsy Queen 30 Mk. 2 @ 250 hp.	191
	D.H. 106	Comet 4	Transport	5	80-76	115'	111' 6"	28' 6"	2,121	70,400	152,500	4 R-R Avon @ 10,500 lb. t.	500*
	D.H. 106	Comet 4B	Transport	4	99	107' 9"	118'	28' 6"	2,059	102,500	152,500	4 R-R Avon 29 @ 10,500 lb.t.	M = .78
	D.H. 106	Comet 4C	Transport	4	99	115'	118'	28' 6"	2,121	102,500	156,000	4 R-R Avon 29 @ 10,500 lb.t.	M = .75
	D.H. 121?	.....	Transport	...	70-100	.....	.....	.....	.....	.....	.....	3 R-R R.B.141 @ 12,000 lb.t.	600+*
The English Electric Co., Ltd. *Marconi House, Strand, London, W.C. 2.*	P. 1B	Lightning	AW Fighter	1	0	34' 10"	50'	19' 5"	.....	.....	.....	2 R-R Avon w/reheat	M>2
	P. 11	Lightning	Trainer	2	0	34' 10"	50'	19' 5"	.....	.....	.....	2 R-R Avon w/reheat	M>2
	B. 6	Canberra	Bomber	2	0	64'	65' 6"	15' 7"	960	.....	.....	2 R-R Avon	...
	P.R. 7	Canberra	Photo Recon.	2	0	64'	66' 8"	15' 7"	960	.....	.....	2 R-R Avon	...
	B(I)8	Canberra	Bomber	2	0	64'	65' 6"	15' 7"	960	.....	.....	2 R-R Avon	...
	P.R. 9	Canberra	Photo Recon.	2	0	68'	69' 8"	15' 7"	960	.....	.....	2 R-R Avon	...
	TSR II	.....	Strike	...	...	.....	.....	.....	.....	.....	.....	B-S Olympus	...
The Fairey Aviation Co., Ltd. *Hayes, Middlesex*	.....	Gannet A.E.W. Mk. 3	Early Warning	3	0	54' 7"	44'	16' 9"	.....	.....	.....	1 B-S Double Mamba @ 3,875 eshp.	...
	.....	Gannet A.S. Mk. 4	Anti-Sub.	3	0	54' 3"	43'	13'	.....	.....	.....	1 B-S Double Mamba @ 3,035 eshp.	...
	.....	Gannet T. Mk. 5	Trainer	3	0	54' 3"	43'	13'	.....	.....	.....	1 B-S Double Mamba @ 3,035 eshp.	...
	.....	Delta 2	Research	1	0	26' 9"	51' 8"	11'	360	.....	.....	1 R-R Avon	M>1
Folland Aircraft Ltd. *Hamble, Southampton, Hampshire*	Fo. 141	Gnat Mk. 1	Fighter	1	0	22' 1"	29' 8"	7' 7"	137	3,917	6,191	1 B-S Orpheus 701 @ 4,520 lb. t.	M = .98
	Fo. 141	Gnat Mk. 2	Fighter	1	0	.....	.....	.....	.....	.....	.....	1 B-S Orpheus w/reheat	M = 1.3
	Fo. 144	Gnat Trainer	Trainer	2	0	24'	30' 9"	9' 7½"	175	5,070	8,360	1 B-S Orpheus @ 4,230 lb. t.	M > .95
Gloster Aircraft Co., Ltd. *Gloucester*	T. 3	Javelin	Trainer	2	0	52'	60'	16'	930	.....	.....	2 B-S Sapphire 6 @ 8,300 lb. t.	...
	F (AW) 7	Javelin	AW Fighter	2	0	52'	56' 4"	16'	930	.....	.....	2 B-S Sapphire 7 @ 11,000 lb. t.	...
	F (AW) 8	Javelin	AW Fighter	2	0	52'	56' 4"		930	.....	.....	2 B-S Sapphire 7 @ 11,000 lb. t.	...
Handley Page, Ltd. *Clarement Road, Cricklewood, London, N.W. 2*	H.P. 80	Victor B. Mk. 1	Bomber	5	0	110'	114' 11"	28' 1½"	.....	.....	.....	4 B-S Sapphire @ 11,000 lb.t.	...
	H.P. 80	Victor B. Mk. 2	Bomber	5	0	110'	114' 11"	28' 1½"	.....	.....	.....	4 R-R Conway @ 17,250 lb.t.	...
	H.P.R. 3	Dart Herald	Transport	2	47	94' 9½"	71' 11"	23' 4"	886	22,808	37,000	2 R-R Dart @ 2,100 eshp.	295
	H.P. 111	Treble One	Transport	...	202	130'	137' 8"	35' 3"	.....	112,000	240,000	4 R-R Conway 11 @ 17,250 lb.t.	545*
	H.P. 113	.....	Transport	2	8-12	71' 3"	71' 6"	17'	775	.....	36,500	2 B-S Orpheus @ 5,250 lb. t.	530*
Hawker Aircraft, Ltd. *Canbury Park Road, Kingston-on-Thames, Surrey*	P. 1121	.....	Strike	1	0	.....	.....	.....	.....	.....	.....	1 DH Gyron	M>1
	P. 1067	Hunter F. 4	Fighter	1	0	33' 8"	48' 10½"	13' 2"	340	.....	.....	1 R-R Avon RA21 @ 8,000 lb. t.	...
	P. 1067	Hunter F. 6	Fighter	1	0	33' 8"	48' 10½"	13' 2"	340	.....	.....	1 R-R Avon RA28 @ 10,000 lb. t.	...
	P. 1101	Hunter T. 7	Trainer	2	0	33' 8"	48' 10½"	13' 2"	340	.....	.....	1 R-R Avon RA21 or RA28	...
Hunting Aircraft Ltd. *Luton Airport, Luton, Bedfordshire*	.....	President	Transport	2	12	64' 6"	46'	16'	400	9,020	13,500	2 Al. Leonides @ 550 hp.	223
	P. 66	Pembroke	Multi	2	10	64' 6"	46'	16'	400	9,178	13,500	2 Al. Leonides @ 550 hp.	223
	P. 56	Provost T. Mk. 1	Trainer	2	0	35' 2"	28' 9"	12' 2"	214	3,350	4,400	1 Al. Leonides @ 550 hp.	201
	P. 84	Jet Provost T. Mk. 3	Trainer	2	0	35' 10"	32' 4"	10' 2"	214	.....	6,195	1 B-S Viper @ 1,750 lb. t.	329
F. G. Miles Ltd. *Shoreham Airport, Sussex*	M. 100	Student	Trainer	1	1	29' 2"	31' 6"	6' 3"	144	2,400	3,900	1 Turb. Marbore II @ 883 lb. t.	298
	M. 100/2	Centurion II	Personal	1	3-4	32' 6"	31' 9"	7' 4"	182	3,882	7,000	1 B-S Viper @ 2,840 lb. t.	419
	HDM 106S	Caravan	Transport	1-2	15	70' 10"	38'	11' 9"	287	4,500	8,000	2 Lyc. GSO-480 B @ 340 hp.	178
	HDM 106T	Turbo-Caravan	Transport	1-2	15-17	70' 10"	38'	11' 9"	287	4,018	8,000	2 Turb. Astazou @ 320 eshp.	185
Edgar Percival Aircraft, Ltd. *Stapleford Aerodrome, Romford, Essex*	EP. 9	.....	Multi	1-2	2-4	43' 0"	30'	10'	227.6	2,010	3,700	1 Lyc. GO-480-B @ 275 hp.	146
A. V. Roe & Co., Ltd. *Greenyate, Middlesex; Manchester*	698	Avro Vulcan B. Mk. 1	Bomber	5	0	99'	97' 1"	26' 6"	.....	.....	.....	4 B-S Olympus	...
	698	Avro Vulcan B. Mk. 2	Bomber	5	0	111'	97' 1"	27' 6"	.....	.....	.....	4 B-S Olympus BOL. 6	...
	696	Avro Shackleton MR. 3	Anti-Sub.	10	0	120' 7"	87' 4"	23' 4"	.....	.....	.....	4 R-R Griffon	...
	748	.....	Transport	3	36-49	95'	67'	28' 3"	795	18,315	31,000	2 R-R Dart R.Da. 6 Mk. 514 @ 1,900 eshp.	300
Scottish Aviation, Ltd. *Prestwick Airport, Ayrshire*	CC. Mk. 1	Pioneer	Transport	1	4	49' 4"	34' 4"	10' 4"	390	4,200	5,800	1 Al. Leonides 530/7 @ 540 hp.	145
	.....	Twin Pioneer	Transport	2	16	70' 6"	45' 3"	12' 3"	679	9,980	14,000	2 Al. Leonides 514/8 @ 1,080 hp.	165
	CC. Mk. 1	Twin Pioneer	Transport	2	16	76' 6"	45' 3"	12' 3"	679	10,170	14,600	2 Al. Leonides 531/8 @ 1,280 hp.	173

Stuart Brothers & Harland Ltd. *P.O. Box 241, Queen's Island, Belfast*	S.B. 5 S.C. 1		Research VTOL	1 1	0 0	30′ 6″ 23′ 6″	45′ 9″ 24′ 4″	16′ 7″ 16′ 7″				1 R-R Derwent 5 R-R RB108	
Vickers-Armstrongs (Aircraft) Ltd. *Weybridge, Surrey*	700D 796	Viscount Viscount	Transport Transport	2 3	40–53 53–63	93′ 8″ 93′ 8½″	81′ 9″ 81′ 9″	27′ 9″ 27′ 9″	963 963	37,200	57,000 61,500	4 R-R Dart 6 @ 1,740 eshp. 4 R-R Dart Mk. 506 @ 1,540 eshp.	330 ...
	800 810 840 950 VC. 10	Viscount Viscount Viscount Vanguard	Transport Transport Transport Transport Transport	3 2 2 3 ...	44–70 44–65 44–65 76–139 147	93′ 8″ 93′ 8″ 93′ 8″ 118′ 140′	85′ 8″ 85′ 8″ 85′ 8″ 122′ 10½″ 158′	26′ 9″ 26′ 9″ 26′ 9″ 35′	963 963 963 1,527 2,800	39,900 40,540 41,130 72,000	60,750 63,750 64,500 127,500 299,000	4 R-R Dart 6 @ 1,740 eshp. 4 R-R Dart 7 @ 1,990 eshp. 4 R-R Dart 11 @ 2,080 eshp. 4 R-R Tyne @ 5,315 eshp. 4 R-R bypass @ 17,500 lb. t.	335 365* 400* 425* ...
	..... 674 ..... TSR II	Scimitar Mk. 1 Valiant Swift F.R. Mk. 5	Fighter Bomber Fighter Strike	1 5 1 ...	0 0 0	37′ 2″ 114′ 4″ 32′ 4″	58′ 4″ 108′ 2″ 41′ 8½″	15′ 34′ 2″ 13′ 6″	.... 306	....	....	2 R-R Avon 200 series 4 R-R Avon 1 R-R Avon B-8 Olympus	... ...
ITALY **Industrie Meccaniche Aeronautiche Meridionali-AERFER** *80, Corso Malta, Naples*	....	A.S. Sagittario II Ariete	Fighter Fighter	1 1	0 0	24′ 7″ 24′ 7″	31′ 2″ 31′ 6″	6′ 7″	158	4,960 5,291	7,160	1 R-R Derwent 9 @ 3,600 lb. t. 1 R-R Derwent+1 R-R Soar	620 M =1.1
Construzioni Aeronautiche Giovanni Agusta *Cascina Costa, Gallarate*	AZ-8L AZ-8S	....	Transport Transport	2 2	22 22	83′ 8″ 83′ 8″	63′ 9″ 63′ 9″	21′ 8″ 21′ 8″	719 719	....	23,810 23,810	4 Al. Leonides Mk. 22 (503/2) @ 470 hp. 4 SNECMA 128 @ 575 hp.	252 ...
Fiat-Divisione Aviazione *Corso G. Agnelli, 200, Turin*	G. 82 G. 91 G. 91T G. 91R F. 86K Vamp. Mk. 52	....	Trainer Fighter Trainer Photo Recon. Fighter Fighter	2 1 2 1 1 1	0 0 0 0 0 0	38′ 8″ ..... 28′ 6″ ..... 37′ 2″ 38′	42′ 5″ ..... 30′ 9″ ..... 40′ 10″ 30′ 9″	13′ 3″ ..... 13′ 11″ ..... 15′ 6′ 2″	271 ..... 176.7 ..... 288 270	9,700 ..... 7,065 6,835	13,780 ..... 11,740 ..... 18,000 10,650	1 R-R Nene RN6121 @ 5,000 lb. t. 1 B-8 Orpheus B. Or. 80302 @ 4,850 lb. t. 1 B-8 Orpheus B. Or. 80302 @ 5,000 lb. t. 1 B-8 Orpheus 3 1 GE J47-GE-17B @ 7,350 lb. t. 1 DH Goblin 3 @ 3,300 lb. t.	575 M>1 640 ... 650 480
Aeronautica Macchi *Corso Vittorio Emanuele 81, Milan*	MB. 326	.....	Trainer	2	0	32′ 11″	34′ 6″	11′ 4″	204.5	4,299	6,283	1 B-8 Viper A8V8 @ 1,750 lb. t.	450
Nardi S.A. per Costruzioni Aeronautiche *Aeroporto Forlanini, Milan*	FN-333	.....	Personal	1	3	34′	24′	10′	161.5	2,028	2,976	1 Con. O-470-H @ 240 hp.	180
Partenavia Costruzioni Aeronautiche *Via Tasso 480, Naples*	P-55 P-57	Tornado Fachiro	Personal Personal	2 2	0 2	23′ 7″ 30′ 2″	19′ 9″ 20′ 3″	5′ 11″ 6′ 4″	86.1 145.3	1,058 1,078	1,566 1,991	1 Lyc. O 320 A @ 150 hp. 1 Lyc. O 320 A @ 150 hp.	215 144
Piaggio & C., Societa per Azioni *Via Antonio Cecchi 6, Genoa (434)*	P. 136-L1 P.136-L2 P. 149-D P. 166 P. 155-CT	....	Personal Personal Personal Personal Amphibian	1 1 1 1 4	4 4 4 7 30	44′ 5″ 44′ 5″ 36′ 6″ 48′ 9″ 102′ 6″	35′ 5″ 35′ 5″ 28′ 11″ 38′ 1″ 98′ 5″	12′ 7″ 12′ 7″ 9′ 6″ 16′ 3″ 31′ 10″	270 270 203 286 1,078	4,420 4,680 2,557 5,004 32,000	6,000 6,615 3,704 7,716 53,000	2 Lyc. GO-480-B1A6 @ 270 hp. 2 Lyc. GSO-480-B1C6 @ 340 hp. 1 Lyc. GO-480-B1A6 @ 270 hp. 2 Lyc. GSO-480-B1C6 @ 340 hp. 2 Allison 501-D13 @ 3,750 eshp.	184 213 192 226 350
NETHERLANDS **Royal Netherlands Aircraft Factories (Fokker)** *Schiphol-Zuid, Amsterdam*	F-27 F-27 F-27	Friendship Friendship "De-Luxe" Freightship	Transport Transport Pass./Cargo	2 2 ...	32–40 16	95′ 2″ 95′ 2″ 95′ 2″	77′ 2″ 77′ 2″ 77′ 2″	27′ 6″ 27′ 6″ 27′ 6″	754 754 754	22,000 23,000	35,700	2 R-R Dart RDa. 6Mk. 511 @ 1,600 eshp. or 2 R-R Dart RDa. 7Mk. 528 @ 1,800 eshp. 2 R-R Dart RDa. 6Mk. 511 @ 1,600 eshp. or 2 R-R Dart RDa. 7Mk. 528 @ 1,800 eshp.	265* 300* 265* 300*
SWEDEN **Svenska Aeroplan Aktiebolagst** *Linkoping*	Saab-J29F Saab-32A Saab-J32B Saab-32C Saab-35 Saab-J35B Saab-90A-2 Saab-91B Saab-91C Saab-91D	..... Lansen Lansen Lansen Draken Draken Scandia Safir Safir Safir	Fighter AW Attack AW Interceptor Photo-Recon. AW Fighter AW Interceptor Transport Trainer Personal Trainer	1 2 2 2 1 1 3 3 1 3–4	0 0 0 0 0 0 40 0 3 0	36′ 1″ 42′ 8″ 42′ 8″ 42′ 8″ 30′ 10″ 30′ 10″ 91′ 11″ 34′ 9″ 34′ 9″ 34′ 9″	33′ 2″ 48′ 1″ 48′ 48′ 1″ 46′ 7″ 46′ 7″ 69′ 11″ 26′ 26′ 26′	12′ 3″ 15′ 8″ 15′ 6″ 15′ 8″ .... 23′ 3″ 7′ 2″ 7′ 2″ 7′ 2″	258 .... 538 ..... 922 146 146 146	9,480 15,500 ..... 15,500 .... 21,960 1,580 1,025 1,570	13,360 22,000 ..... 22,000 18,000 ..... 35,270 2,315 2,685 2,660	1 Sven. RM-2 @ 6,175 lb. t. 1 Sven. RM-5 @ 9,500 lb. t. 1 Sven. RM-6 @ 15,000 lb. t. 1 Sven. RM-5 @ 9,500 lb. t. 1 Sven. RM-6 @ 15,000 lb. t. 1 R-R 2 P&W R2180-E1 @ 1,800 hp. 1 Lyc. 0435-A @ 190 hp. 1 Lyc. 0435-A @ 190 hp. 1 Lyc. 0360 @ 180 hp.	660 700 ... 700 M1.8 M>2 277 170 190 168
SWITZERLAND **Pilatus Flugzeugwerke A.G.** *Stans, Nr. Lucerne*	P-3	.....	Trainer	2	0	34′ 1″	28′ 8″	10′	177	2,447	3,120	1 Lyc. GO-435-C2A @ 260 hp.	192

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2 *Weatherhead Braid-Lok end fittings* factory-installed, rigidly tested—are more than a match for the hose itself in providing enduring protection against blow-offs and leakage. Resistant to vibration and fatigue, permanently attached hose ends grip the outer wire braid, lock it between two metal surfaces and trap the Teflon liner independently to form a perfect seal. End configurations available to mate with flared or flareless connections.

Also available... Weatherhead reusable †*"super gem"* fittings can be attached or detached in the field.

†Aeroquip Trademark

WEATHERHEAD AVIATION and MISSILE GROUP

In Canada: 127 Inkerman Street, St. Thomas, Ontario • Export Cable Address: WEATHCO, Cleveland

Circle Number 123 on Reader-Service Card

Leading Foreign Gas Turbines—1

Manufacturer and Address	Designation	Type	No. of Compressor Stages	No. of turbine stages	No. of combustors	Max. power @ S.L.	Specific fuel consumption at max. power	Compression ratio at max. rpm.	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, less subjets, lb.	Remarks
CANADA												
Orenda Engines, Ltd. *Malton, Ont.*	Orenda 10	AFJ	10	1	6	6,355 lb. t.	1.12	5.3	42	123	2,515	
	Orenda 11	AFJ	10	2	6	7,275 lb. t.	0.99	6.1	45	121	2,425	
	Orenda 14	AFJ	10	2	6	7,275 lb. t.	0.99	6.1	45	121	2,425	
	Iroquois PS-13	AFJ	10	3	An.	20,000+lb. t.	.....	8	47	228	4,650	
GREAT BRITAIN												
Blackburn & General Aircraft, Ltd. *Brough, E. Yorkshire*	A. 129	CFJ	3	2	1	940 lb. t.	0.70	6.5	20	80.5	390	
Bristol Siddeley Engines, Ltd. *Filton, Bristol*	Proteus 705	ACFP	12A, 1C	2, 2	8	3,900 eshp.	0.62	7.2	40	100.6	2,945	Britannia 102.
	Proteus 755	ACFP	12A, 1C	2, 2	8	4,160 eshp.	0.60	7.2	40	100.6	2,900	Britannia 300.
	Proteus 765	ACFP	12A, 1C	2, 2	8	4,445 eshp.	0.6	7.2	40	100.6	2,900	Britannia 250, 310, 320.
	Olympus 101	AFJ	6A, 8A	1, 1	A	11,060 lb. t.	0.82	.....	41	128	3,600	
	Olympus 102	AFJ	7A, 8A	1, 1	A	12,000 lb. t.	0.81	.....	42	132	3,900	
	Olympus 104	AFJ	.....	.....	A	13,000 lb. t.	.....	.....	42	132	.....	
	Olympus 200	AFJ	.....	.....	A	16,000 lb. t.	.....	.....	42	126.4	.....	
	Olympus 201	AFJ	.....	.....	A	17,000 lb. t.	.....	.....	41.75	126.4	.....	Vulcan B. Mk. 2.
	Orpheus B. Or. 2	AFJ	7	1	A	4,520 lb. t.	.....	.....	32	72	790	Folland Gnat.
	Orpheus B. Or. 3	AFJ	7	1	A	4,850 lb. t.	1.06	.....	32	75.45	825	G. 91, Etenard VI, Theo.
	Orpheus B. Or. 4	AFJ	.....	.....	.....	4,230 lb. t.	0.96	.....	32	75.55	890	Gnat trainer, G. 91, Jet Star.
	Orpheus B. Or. 11	AFJ	.....	.....	A	5,760 lb. t.	.....	.....	32	79.27	.....	
	Orpheus B. Or. 12	AFJ	.....	.....	A	8,000 lb. t.	.....	.....	32	82.7	.....	Afterburner; basic thrust 6,610
Armstrong Siddeley *Coventry*	Double Mamba ASMD. 3	AFP	10	3	A	3,145 eshp.	0.72	5.35	53	99	2,180	
	Double Mamba ASMD. 8	AFP	11	3	A	3,875 eshp.	0.67	5.85	56	103	2,460	
	Viper ASV. 8	AFJ	7	1	A	1,750 lb. t.	1.07	41	24	67	530	Provost Mk. 3.
	Viper ASV. 9	AEJ	7	1	A	1,900 lb. t.	1.14	4.25	24	67	525	Uprated ASV. 8.
	Viper ASV. 10	AFJ	7	1	A	2,000 lb. t.	1.01	3.45	24.5	64	570	
	Viper ASV. 11	AFJ	7	1	A	2,460 lb. t.	1.04	4.37	24.5	64	570	Production
	Viper ASV. 12	AFJ	7	1	A	2,700 lb. t.	.....	.....	24.5	64	580	
	Sapphire ASa. 6	AFJ	13	2	A	8,300 lb. t.	0.87	7.5	37	110	2,670	Production.
	Sapphire ASa. 7	AFJ	13	2	A	11,000 lb. t.	0.88	7.49	37	108	3,050	Production.
	Sapphire ASa. 7R	AFJ	13	2	A	12,230 lb. t.	1.38	7.49	37	108	3,050	Limited afterburner.
	P. 181	ACFP	2A, 1C	2, 1	A	1,020 shp.	0.73	5.9	27.45	60.82	846	Helicopter engine.
	P. 182	ACFP	2A, 1C	2, 1	A	1,100 shp.	0.69	5.9	27.45	60.22	625	Turboprop version of P. 181.
De Havilland Engine Co., Ltd. *Leavesden, Hertfordshire*	Goblin 35	CFJ	1	1	16	3,500 lb. t.	1.16	3.7	50	110	1,630	DH Vampire Trainer.
	Ghost 103	CFJ	1	1	10	4,850 lb. t.	1.15	4.5	53	123	1,925	DH Venom F.B. Mk. 4.
	Ghost 105	CFJ	1	1	10	5,300 lb. t.	1.19	4.7	53	120	1,935	DH Sea Venom N.F. Mk. 22.
	Gyron D. Gy. 2	AFJ	7	2	A	20,000 lb. t.	.....	1.04	50	156	4,270	
	Gyron Jr. D.G.J. 1	AFJ	.....	.....	.....	7,000 lb. t.	.....	.....	35	122	.....	
	Gyron Jr. D.G.J. 10	AFJ	.....	.....	.....	.....	.....	.....	32	70	.....	Uprated model for supersonic use.
	Gnome D. Ge. 1	ACS	10	2, 1	1	1,000 shp.	0.65	8	16	55	275	Licensed GET58; copters.
	Gnome P. 1000	AFP	10	2, 1	1	1,000 shp.	0.67	8	33	76	535	
D. Napier & Son, Ltd. *London*	Eland N. El. 1	AFP	10	3	6	3,060 eshp.	0.64	7	36	122	1,570	
	Eland N. El. 3	AFP/G	10, 9	3	6	3,000 eshp.	0.62	7	36	158	2,435	
	Eland N. El. 6	AFP	10	3	6	3,500 eshp.	0.60	7	36	115	1,820	Convair 340/440.
	Eland N. El. 7	AFP	10, 9	3	6	3,500 eshp.	0.60	7	36	158	2,575	Uprated N. El. 3.
	Eland E. 211	.....	10	3	6	3,500 eshp.	.....	7	36	135	1,415	Twin-unit for Westminster.
	Oryx N. Or. 1	AFG	12, 4	2	5	750 ghp.	0.68	6	19	83	495	
	Oryx N. Or. 4	AFG	12, 4	2	5	865 ghp.	0.65	6	19	83	495	
	Oryx N. Or. 5	AFG	12, 4	2	5	950 ghp	0.62	6.1	19	83	515	
	Gazelle N. Ga. 1	AFP	11	2+1	6	1,280 shp.	0.71	6.37	34	70	780	
	Gazelle N. Ga. 2	AFP	11	2+1	6	1,650 shp.	0.68	6.37	34	70	830	
	Gazelle N. Ga. 3	AFP	11	2+1	6	1,800 shp.	0.66	6.37	34	70	865	
	Gazelle N. Ga. 4	AFP	11	2+1	6	2,000 shp.	0.635	6.37	34	70	900	
Rolls-Royce, Ltd. *Derby*	Avon RA. 7	AFJ	12	2	8	7,500 lb. t.	0.92	6.5	42	112	2,460	
	Avon RA. 7R	AFJ	12	2	8	9,500 lb. t.	1.00	6.5	42	130	2,695	Afterburner.
	Avon RA. 21	AFJ	12	2	8	8,000 lb. t.	0.93	6.5	42	117	2,478	
	Avon RA. 14	AFJ	15	2	A	9,500 lb. t.	0.84	7.8	42	113	2,697	
	Avon RA. 26	AFJ	15	2	A	10,000 lb. t.	0.86	.....	42	113	2,790	
	Avon RA. 28	AFJ	15	2	A	10,000 lb. t.	0.86	.....	42	113	2,880	Modified RA. 26 in Ryan X-13.
	Avon RA. 24	AFJ	15	2	A	11,250 lb. t.	.....	.....	.....	.....	.....	
	Avon RA. 24R	AFJ	15	2	A	.....	.....	.....	.....	.....	.....	Afterburner.
	Avon RA. 29	AFJ	16	3	A	10,300 lb. t.	0.775	.....	42	126	3,326	D.H. Comet, Sud Caravelle.
	Conway RCo. 5 & 7	BPJ	.....	.....	A	13,000 lb. t.	.....	.....	42	129	.....	
	Conway RCo. 10	BPJ	.....	.....	A	16,500 lb. t.	.....	.....	42	131	.....	707, DC-8
	Conway RCo. 11	BPJ	.....	.....	A	17,250 lb. t.	.....	.....	42	136	.....	
	Conway RCo. 12	BPJ	.....	.....	.....	17,860 lb. t.	.....	.....	42	131	.....	Civil.
	Conway RCo. 15	BPJ	.....	.....	.....	18,500 lb. t.	.....	.....	42	131	.....	Civil.
	R.B. 141	BPJ	.....	.....	.....	.....	.....	.....	.....	.....	.....	Civil.
	R.B. 145	BPJ	.....	.....	.....	2,750 lb. t.	.....	.....	.....	.....	.....	DH 121.
	R.B. 108	AFJ	.....	.....	A	2,010 lb. t.	.....	.....	.....	.....	.....	VTOL engine; Short S.C. 1.
	Dart Mk. 506	CFP	2	2	7	1,540 eshp.	0.727	5.5	38	98	1,030	Viscount 700 & 800.
	Dart Mk. 510	CFP	2	2	7	1,740 eshp.	0.689	5.5	38	98	1,110	
	Dart Mk. 511	CFP	2	2	7	1,720 eshp.	0.698	5.5	38	98	1,195	Fokker/Fairchild F. 27.
	Dart Mk. 520	CFP	2	3	7	1,890 eshp.	0.7	5.8	38	98	1,250	Viscount 806.
	Dart Mk. 525	CFP	2	3	7	1,990 eshp.	0.68	5.8	38	98	1,250	Viscount 810.
	Dart Mk. 526	CFP	2	3	7	2,100 eshp.	0.665	5.8	38	98	1,250	A.W. 650 Freighterconch.
	Dart Mk. 527	CFP	2	3	7	2,100 eshp.	0.665	5.8	38	98	1,260	H.P. Dart Herald.
	Dart Mk. 528	CFP	2	3	7	1,960 eshp.	0.690	5.8	38	98	1,273	Fairchild F. 27.
	Dart Mk. 529	CFP	2	3	7	2,100 eshp.	0.665	5.8	38	98	1,269	Grumman Gulfstream.
	Dart Mk. 21	CFP	2	3	7	2,150 eshp.	0.610	5.8	38	98	1,240	1050 Alize.
	Dart RDa. 10	CFP	2	3	7	2,660 eshp.	0.64	6.25	38	98	1,323	
	Dart Mk. 541	CFP	2	3	7	2,350 eshp.	0.675	6.25	38	98	1,323	Viscount 840.
	Tyne RTy. 1	AFP	6+9	1+3	A	4,985 eshp.	0.499	13.1	41	110	2,220	Vanguard.
	Tyne RTy. 11	AFP	6+9	1+3	A	5,525 eshp.	0.48	13.1	41	110	2,124	Vanguard.
	Tyne RTy. 12	AFP	6+9	1+3	A	5,730 eshp.	0.449	13.1	41	110	2,220	Canadair CL-44.

Abbreviations:
A — Annular
ACFJ — axial-centrifugal turbojet
ACFP — axial-centrifugal turboprop
AFG — axial-flow gas generator
AFJ — axial-flow turbojet
AFP — axial-flow turboprop
BPJ — bypass turbojet
CFJ — centrifugal-flow turbojet
CFP — centrifugal-flow turboprop
eshp. — equivalent shaft horsepower
ghp. — gas horsepower
lb. t. — pounds thrust
' — Guaranteed minimum power.

Leading Foreign Gas Turbines—2

Manufacturer and Address	Designation	Type	No. of compressor stage	No. of turbine stages	No. of combustors	Max. power @ S.L.	Specific fuel consumption at max. power	Compression ratio at max. rpm.	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, less tailpipe lb.	Remarks
FRANCE												
Generale Aeronautique Marcel Dassault *St. Cloud*	M.D. 30 Viper	AFJ	7	1	A	1,630 lb. t.	1.10	3.8	27	66	496	Bristol-Siddeley license.
	M.D. 30R	AFJ	7	1	A	2,205 lb. t.	2.30	3.8	27	132	761	M.D. 30 with afterburner.
	R. 7	AFJ	7	1	A	3,085 lb. t.	1.07	3.8	29	79	748	
Societe d'Exploitation des Materiels Hispano-Suiza *Boise-Colombes*	Atar D2A, D3	AFJ	7	1	A	6,000 lb. t.	1.03	4.5	36	141	1,895	
	Atar E3	AFJ	8	1	A	7,715 lb. t.	1.05	4.8	39	163	1,851	
	Atar E4	AFJ	8	1	A	8,150 lb. t.	1.06	4.8	39	163	1,851	
	Atar E5	AFJ	8	1	A	8,150 lb. t.	1.06	4.8	39	162	1,851	
	Atar G2, G3	AFJ	8	1	A	9,700 lb. t.	1.85	4.8	40	253	2,720	
	Atar G8	AFJ	9	2	A	9,700 lb. t.	0.98	5.2	40	181	2,182	
	Atar G9	AFJ	9	2	A	13,250 lb. t.	2.07	5.2	42	264	2,760	
Societe Turbomeca *Paris*	Palas	CFJ	1	1	A	352 lb. t.	1.17	3.95	16	47	158	
	Marbore 2	CFJ	2	1	A	880 lb. t.	1.15	3.85	25	62	314	
	Marbore 4	CFJ	1	1	A	1,000 lb. t.	1.20	3.5	25	62	300	
	Arbison	.....	.....	2	A	552 lb. t.	0.90	5.5	21	57	236	
	Gourdon	ACFJ	2	2	A	1,545 lb. t.	1	6	24	75	386	
	Gabizo	ACFJ	2	1	A	2,400 lb. t.	1.04	5.2	21	82	565	
	Soulor	ACFJ	2	2	A	704 lb. t.	0.8	5	18	80	354	
	Artouste 2	CFP	1	2	A	398 eshp.	1.07	3.8	23	67	288	
	Artouste 3	ACFP	2	3	A	844 eshp.	0.65	5.5	21	58	318	
	Bastan	ACFP	2	3	A	741 eshp.	0.67	5.2	21	61	396	
	Marcadau	CFP	1	2	A	386 eshp.	1.07	3.6	22	57	350	
	Palouste 4	CFG	1	2	A	2.54 lb. air/sec.	.....	3.9	22	53	200	
	Astan 2	ACFG	2	3	A	3 lb. air/sec.	.....	5.1	21	54	250	
	Turmo 2	CFP	1	2	A	996 eshp.	1.07	3.9	26	49	320	
	Turmo 3	CFP	2	3	A	736 eshp.	0.72	5.5	31	66	530	
	Astazou	ACFP	2	3	A	330 eshp.	0.72	.....	18	46	234	
	Tramontane	.....	1	2	A	5.5 lb. air/sec.	.....	3.5	23	47	370	
ITALY												
FIAT-SMA *Turin*	4002	CFJ	1	1	A	550 lb. t.	1.25	4	22	41	220	

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CFJ — centrifugal-flow turbojet
CFP — centrifugal-flow turboprop
eshp. — equivalent shaft horsepower
ghp. — gas horsepower
lb. t. — pounds thrust
1 — Guaranteed minimum power.

USSR Military and Civil Aircraft

Basic Data				Physical Data			Performance			Armament	Remarks
	Designation	NATO Code Name	No. of Crew	Wing Span, ft.	Length, ft.	Gross Weight, lb.	Powerplant (No. & Type, Rated hp)	Maximum Speed, mph	Service Ceiling, ft.	No. and Type of Guns	
FIRST-LINE AIRCRAFT											
STRATEGIC BOMBERS	.....	.....	...	78	195	300,000	2 x tj @ 35,000 lb.t. 2 x nuclear @ 70,000 lb.t.	.....	.....	.....	Nuclear bomber prototype; credited to designer V. M. Myasishchev
	Type 37	Bison	...	176	140	250,000	4 x Lulko tj. @ 19,500 lb.t.	610	57,000	.....	Equipped for aerial refueling.
	Tu-20	Bear	...	180	150	320,000	4 x tp. @ 12,000 eshp.	550	50,000	.....	Range about 8,000 mi.
	Tu-16	Badger	...	100	105	150,000	2 x Lulko tj. @ 19,500 lb.t.	600	50,000	.....	Comparable to Boeing B-47.
TACTICAL BOMBERS	Il-28	Beagle	3	68	62	.....	2 x RD-45 tj. @ 5,000 lb.t.	600	45,000	2 x 23-mm. 2 x 12.7-mm.	Satellite production and use.
	Il-30	Blowlamp	2	57	70	.....	2 x tj. @ 17,000 lb.t.	750	.....	.....	55-deg. wing sweepback.
	Tu-14	Bosun	3	70	65	50,000	2 x VK-1 tj. @ 5,000 lb.t.	500	.....	.....	Navy torpedo bomber.
	.....	Backfin	3	75	85	.....	2 x tj. @ 17,000 lb.t.	900	.....	.....	Experimental prototype flew summer 1957; 50-deg. wing sweepback.
FIGHTERS	MiG-21	Faceplate	1	33	50	.....	1 x axial tj. @ 22,000 lb.t.	1,300	60,000	.....	Operational.
	MiG-?	Fitter	1	.....	...	.....	1 x axial tj.? @ 22,000 lb.t.	1,000	.....	.....	Competitor to MiG-21; not in production; used area rule.
	MiG-19	Farmer	1	.....	...	27,000	2 x axial tj. @ 10,000 lb.t.	900	55,000	2 x 23-mm.	Low-set slab tail; 3,000 in service.
	Su-15	Fishpot	1	25	50	.....	1 x axial tj. @ 22,000 lb.t.	1,300	60,000	.....	Delta; 84-in. tailpipe dia. all-weather; in production
	Su-16	Fishbed	...	.....	...	.....	.....	.....	.....	.....	Competition to Su-15; not in production.
	Yak-25	Flashlight A	2	40	...	.....	2 x axial tj. @ 8,000 lb.t.	700	.....	2 x 37-mm.	Standard operational all-weather fighter.
	Yak-?	Flashlight B	2	40	55	30,000	2 x axial tj.	800	.....	.....	Light bomber.
	Yak-?	Flashlight C	2	40	55	30,000	2 x axial tj.	800	.....	.....	All-weather; in production.
	MiG-17	Fresco	1	33	37	15,000	1 x VK-2JA tj. @ 6,850 lb.t.	M>1	51,000	2 x 23-mm. 1 x 37-mm.	MiG-15 development.
	MiG-15	Fagot	1	33	36	11,268	1 x VK-2 tj. @ 5,950 lb.t.	660	51,000	2 x 23-mm. 1 x 37-mm.	Satellite production and use; minimum 15,000 built.
HELICOPTERS	Mil-1	Hare	4	48.5[1]	...	4,938	1 x ASh-26B @ 575 hp.	105	.....	.....	Range 400 mi.
	Mil-3	.....	4	47[1]	39	5,180	.....	124	.....	.....	Mi-1T development.
	Mil-4	Hound	2	69[1]	...	12,015	1 x ASh-82V @ 1,700 hp.	130	11,800	None	Aeroflot uses 10-place Mi-4P.
	Mil-6	Hook	...	.....	...	.....	2 x axial tj. @ 4,000 lb.t.	.....	.....	.....	New FAI record: 26,463 lb. to 7,870-ft. altitude.
	Yak-24	Horse	4	60[1]	75	35,000	2 x ASh-82B @ 1,430 hp	.....	.....	None	Holds two FAI records.
	Ka-18	Hog	...	.....	...	.....	1 x 250 hp.	.....	.....	.....	Coaxial rotor, 4 passenger.
	Ka-10	Hat	1	.....	...	440	1 x 55 hp.	.....	5,000	.....	Coaxial rotor.
	Ka-15	Hen	...	.....	...	.....	1 225 hp.	93	19,000	.....	Coaxial rotor, 2 passenger.
TRANSPORTS	An-2	Colt	2	54	35	11,000	1 x ASh-621A @ 1,000 hp.	137	27,890	None	Holds FAI altitude record.
	An-4	Camp	...	.....	...	77,160	2 x NK tp. @ 4,000 eshp.	.....	.....	Tail turret	Assault transport; Aeroflot freighter.
	An-10	Cat	3-5	.....	...	.....	4 x NK&Iv tp, @ 4,000 eshp.	480	30,000	None	85 passengers; An-10A carries 100.
	An-16	.....	...	.....	...	.....	4 x NK&Iv tp. @ 4,000 eshp.	.....	.....	None	130 passengers; like An-10.
	An-14	(Little Bee)	...	65	36	7,050	2 x Iv AI-14R	143	.....	None	Antonov design; 6 passengers.
	Il-12	Coach	2-5	104	70	38,000	2 x ASh-82FNV @ 1,850hp.	252	.....	None	USSR, Polish, Czech airlines; 3,000 built.
	Il-14	Crate	2-5	104	70	36,400	2 x ASh-82T @ 1,900 hp.	200	1,990	None	Il-12 development/replacement; prod. 30/month.
	Il-14M	Crate	...	.....	...	.....	.....	.....	.....	None	24-passenger version.
	Il-18	Coot	3-5	.....	...	.....	4 x NK&Iv tp.@ 4,000 eshp.	.....	30,000	None	70-100 passengers; 2,600-mi. range.
	Tu-70	Cart	4	141	119	.....	4 x ASh-82FNV @ 1,550 hp.	215	.....	None	Tu-4 development (Boeing B-29 copy).
	Tu-104	Camel	3	114	121	120,152	2 x M-209 tj. @ 14,880 lb. t.	560	30,000	None	ICAO range; 1,988 mi.
	Tu-104A	Camel A	3	.....	.....	.....	.....	560	.....	None	70 passengers; Tu-104B carries 100.
	Tu-110	Cooker	3	122	125	142,152	4 x M-209 tj. @ 15,000 lb.t.	600	36,000	None	2,600-mi. nonstop full-load range; 80 passengers 1st class, 100 tourist.
	Tu-114	Cleat	4	.....	...	.....	4 x NK-12M tp. @ 12,000 eshp.	550	35,000	None	Moscow-N.Y. nonstop capability with 100 passengers.
	Tu-114D	.....	...	180.5	...	240,000	4 x NK-12M tp. @ 12,000 eshp.	.....	.....	.....	.....
	Li-2	Cab	2	95	64	.....	2 x M-62R @ 1,000 hp.	.....	.....	.....	USSR-built Douglas DC-3.
	Be-6	Madge	...	108	...	31,000	2 x ASh-73 @ 2,000 hp.	260	3,048	.....	Patrol flying boat similar to Martin P5M-1.
SUPPORT AIRCRAFT											
BOMBERS	Il-10	Beast	2	45.5	40	.....	1 x AM-12 @ 2,000 hp.	300	.....	1 x 12.7-mm. 2 x 7.62-mm.	Satellite use.
	Il-26	Butcher	3	68	62	.....	2 x axial tj. @ 5,000 lb.t.	570	45,000	2 x 23-mm. 1 x 20-mm.	Production predecessor of Il-28.
	Tu-4	Bull	6-8	141	99	.....	4 x ASh-82FNV @ 1,850 hp.	225	.....	.....	Russian copy of Boeing B-29.
	Tu-?	Barge	...	185	145	210,000	4 x tp. @ 4,500 eshp.	380	.....	.....	Pre-production quantities; turboprop testbed for Bear.
	Tu-2	Bat	5	61.9	45.3	28,224	2 x ASh-82FNV @ 1,850 hp.	360	36,000	2 x 20-mm. 2 x 12.7-mm.	Polish and Red Chinese service.
FIGHTERS	La-7	Fin	1	32.3	28.5	7,482	1 x ASh-82FNV @ 1,850 hp.	373	.....	.....	Second-line Red Chinese fighter.
	La-9	Frits	1	31.4	29.4	8,230	1 x ASh-82FNV @ 1,850 hp.	394	.....	1 x 20-mm. 2 x 12.7-mm.	Russian trainer; Chinese fighter.
	La-11	Fang	1	32.5	28.4	7,700	1 x ASh-82FNV @ 1,850 hp.	429	.....	3 x 20-mm.	Last USSR piston-eng. fighter.
	La-?	Fantail	1	37	40	.....	1 x RD-45F @ 5,300 lb.t.	640	.....	2 x 23-mm.	Type 21; was called La-17.
	MiG-9	Fargo	1	34	33	14,000	2 x M-004 @ 2,200 lb.t.	595	.....	2 x 20-mm. 1 x 23-mm.	First USSR twin-jet; now trainer.
	Yak-17	Feather	1	30	28	.....	1 x M-004 @ 2,200 lb.t.	565	.....	2 x 20-mm.	Yak-15 development.
	Yak-23	Flora	1	30	29	.....	1 x RD-500 @ 3,500 lb.t.	610	45,000	.....	Polish, Bulgarian service.
	Yak-3	.....	1	31	29	4,848	1 x VK-105PF @ 1,210 hp.	343	.....	1 x 20-mm.	.....
TRAINERS	Yak-18A	.....	2	.....	...	.....	1 x radial piston	161	16,897	.....	Tricycle gear.
	Yak-18P	.....	1	.....	...	.....	1 x radial piston	174	21,982	.....	Tricycle gear.

Abbreviations:
AM—A. A. Mikulin
An—O. K. Antonov
ASh—A. D. Shvetsov
Il—Sergei Ilyushin
Iv—A. G. Ivchenko
Ka—Nicolai Kamov
La—Semyon Lavechkin

[1] Rotor diameter
M—Motor (old designation)
MiG—Artem Mikoyan & Mikhail Gurevich
Mil—Mikhail Mil
NK—N. D. Kuznetzov
Su—Pavel Sukho
tj—turbojet engine
tp—turboprop engine
Tu—Andrei Tupolev
VK—V. Klimov
Yak—Aleksandr Yakovlev

Other NATO code names given to Russian types include: Fred, Box and Bank (Boeing P-63A, Douglas A-20 and North American B-25 respectively, sent to USSR under Lend-Lease during WW II): Bob (Il-4), Bark (Il-2), Clam (Il-12 four-engine transport), Crib (Yak-6), Crow (Yak-14), Mark (Yak-7), Moto (MBR-2) and the undisclosed Mole, Mare and Mist.

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The means:

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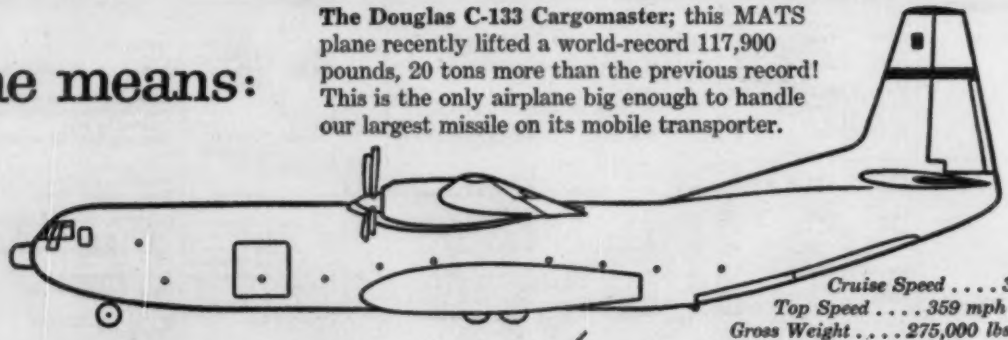

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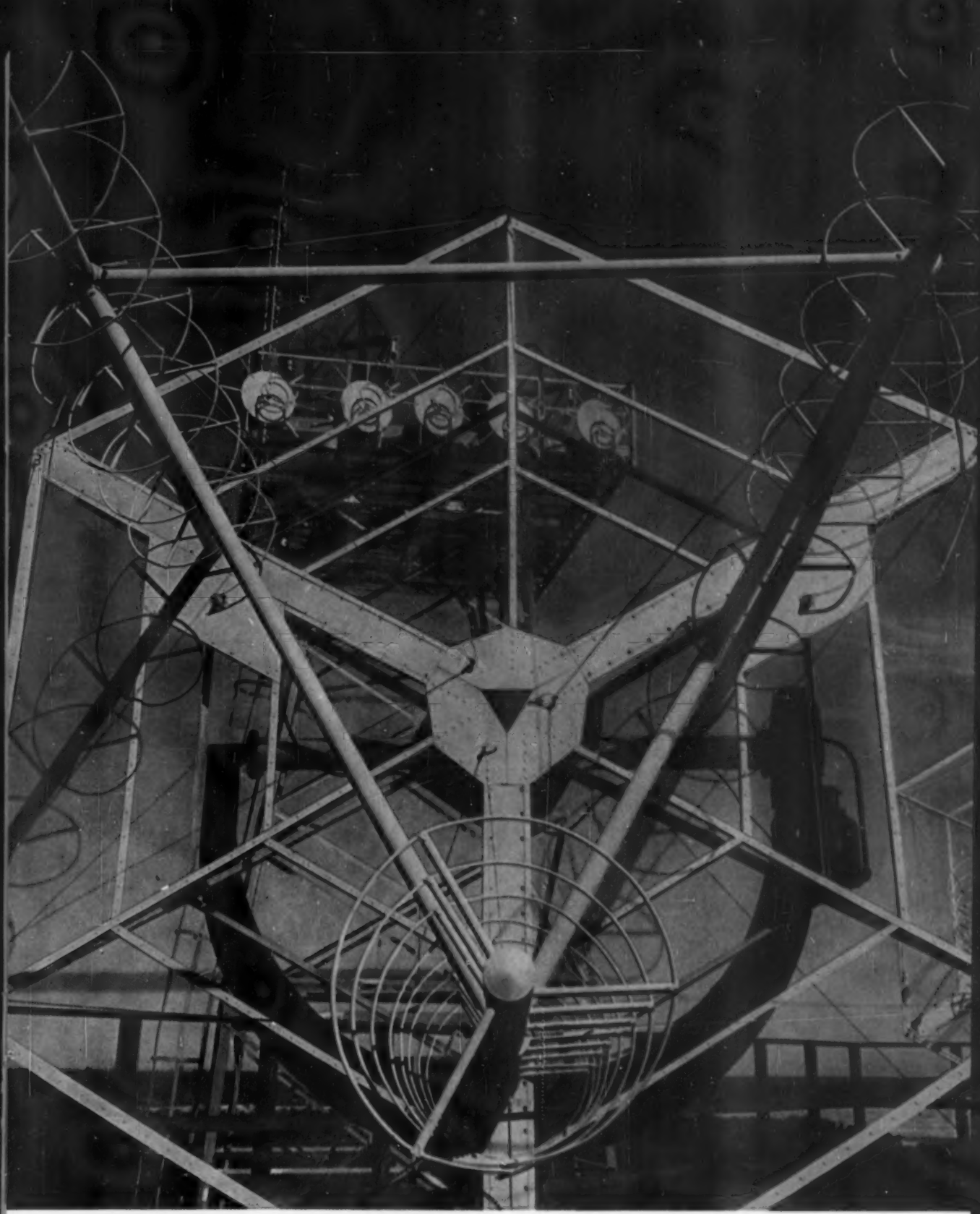
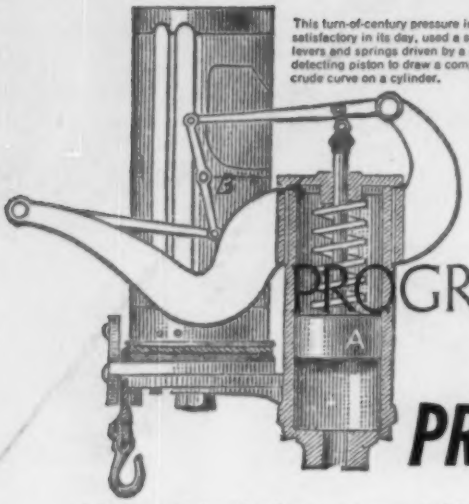


D. S. KENNEDY tri-helix telemetry antenna at the Air Force Missile Test Center, Patrick AFB, Fla.

Avionics



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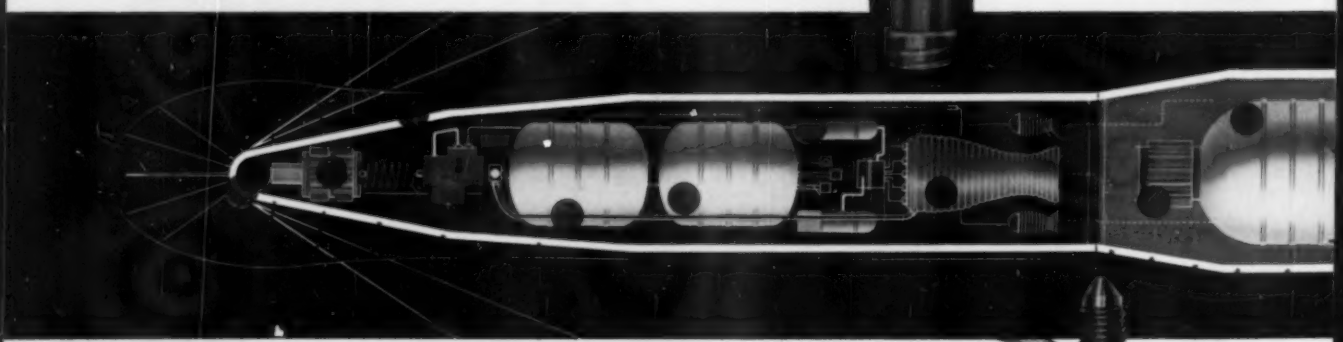

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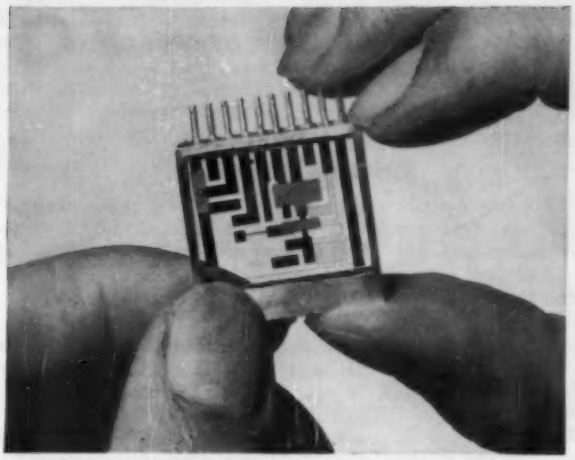

MICRO-MINIATURIZED flip-flop circuit developed by Hughes Aircraft, with tiny transistor crystals imbedded directly in the circuitry, reflects one of many changes taking place in avionics business as result of trend toward missiles and space vehicles.

LABORATORY type facilities, similar to those now used for gyro assembly, may replace conventional avionic factory facilities for fabrication of such micro-miniature units to provide greater cleanliness and improved reliability.

Pattern of Avionics Business to Change

By Philip J. Klass

Washington—Avionics business will undergo a significant change during the next several years as a direct result of the current trend toward more complex weapon systems, procured in smaller quantities, and the needs of the nation's space program.

This change will not only affect avionic companies' operations but may also adversely affect their net profits, unless Defense Department acts in recognition of the changing industry pattern.

Here are some of the likely consequences of current trends:

• **Large production runs** of avionic equipment, such as the industry has known during the past decade, will largely disappear except for a few programs—assuming no radical change in international relations. Avionics manufacturing will become largely a model-shop type operation, with individual equipments being "coddled" throughout manufacture to assure maximum reliability.

• **Military sponsored developments** will be aimed primarily at devising fundamentally new techniques instead of developing hardware for hardware's sake as in the past. Emphasis will shift to the basic physics of solving a problem, with hardware fabrication primarily to prove out the principle.

• **Increased demand for scientists** and engineers with a strong theoretical background or mechanical ingenuity appears certain. Engineers and scientists, who now represent about 10% of the total employment in avionics companies, may constitute 20 to 25% of company totals in a few years.

• **Low profit developments**, which some companies accept in hope of recouping on subsequent large-scale production, will sap industry's financial strength unless Defense Department revises the profit margin it allows on development and study programs.

• **Avionic component manufacturers** who produce resistors, capacitors, transistors, motors, gyros, etc. will continue to enjoy customary production runs—at least for a while. However, current space vehicle requirements for ultra-light weight, small size and reliability, coupled with current research on molecular electronic techniques for fabricating entire circuits in an integral operation, may eventually confront component manufacturers with a radical change in their own operations.

Procurement Trends

Growing complexity of individual weapon systems, coupled with an essentially fixed defense budget, means procurement of fewer weapon systems—both in terms of the number of different weapons which can be developed and the number which ultimately are produced.

This trend can be clearly seen in the area of strategic bombers. In contrast to the several thousand B-47s that were manufactured and the fewer than a thousand B-52s now built or programed, production of the B-58 may never exceed 100. Procurement of the B-70 may be only several dozen or fewer.

This situation is aggravated by the fact that the time required to bring weapon systems from initial concept into production increases with their growing complexity.

This means that by the time a weapon is ready for production, a newer, more glamorous one with greater potential capability is in the concept stage and this serves to considerably hold back wide scale production of the former weapon.

Good examples can be found in the ballistic missile field. Production of the Atlas ICBM is held down because the improved Titan is just around the corner and there are some who suspect the Titan may not see production because of the solid-propellant Minuteman development only a couple years beyond.

Even in the field of small air-to-air missiles, the successor to the relatively simple, high-production Navy Sidewinder and Sparrow I and III, will be the new long-range Eagle missile, a considerably more complex weapon.

Production of satellites and space vehicles will involve extremely small-scale manufacturing operations for at least the next few years.

Increased share of defense dollars going into missiles means smaller production runs, although not necessarily fewer total dollars, for most avionics manufacturers. One exception is in the field of guidance, where there is a decided trend toward increased use of missile-borne inertial systems because

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of their invulnerability to jamming.

Otherwise the trend is toward less airborne equipment and more ground, ship-based avionic equipment for automatic check-out, launch and maintenance. This also indicates smaller production runs.

This means that when an avionic manufacturer buys new machine tools, the emphasis will be on flexibility rather than speed. Manufacturers will seek new techniques which will permit maximum manufacturing economies, despite small production runs. Typical of such machines, aimed at flexibility rather than speed, is the automatic wire-wrap machine developed by Keller Tool Division of Gardner-Denver Co. for Hughes Aircraft Co. (AW Dec. 29, p. 58.) This machine, which operates from punched card or tape commands, is quickly converted from one production run to another.

Techniques vs. Hardware

Military laboratories, which formerly sponsored development of equipments and hardware, then assigned them to aircraft, recognize that their traditional role is changing rapidly as a result of the trend toward Weapon System Management, missiles and space vehicles.

However, the weapon system prime is not authorized to spend funds to advance the general state-of-the-art so that required techniques will be available to meet the needs of the next generation of weapon systems. This vital mission, which military laboratories have carried out in the past, will probably become their primary role in the future.

Although everyone gives lip service to the need for state-of-the-art research, such programs must fight for funds against the more glamorous weapon system programs.

Discussion with officials of several Wright Air Development Center laboratories reveals that the bulk of their future development funds will go for advancing the state-of-the-art, much of it for "big-step-forward" type projects involving high risk but large potential pay-offs.

Typical are the "exotic" gyroscope programs which WADC's Weapons Guidance Laboratory already are sponsoring. One, at General Precision Laboratory, is exploring the possibility of utilizing spinning electrons instead of a spinning wheel for a displacement gyroscope. Within recent weeks this program has begun to look most promising, a Laboratory official says. Another program, at Gulton Industries, is investigating feasibility of a crystal rate gyro.

Another basic investigation, aimed at finding entirely new ways of performing conventional avionic circuit functions, is being carried out by several universities under sponsorship of WADC's Electronic Components Laboratory. Investigation is re-examining dozens of physical phenomena, many of them discovered a hundred or more years ago which have remained largely scientific curiosities. For example, the Peltiere Effect, discovered over a century ago, recently has come into use as a technique for obtaining refrigeration cooling without using any moving parts.

Areas Of Interest

Here are a few of the problem areas in which WADC laboratories hope to sponsor programs, providing contractors produce significantly new ideas:

• **Target recognition:** Weapons Guidance Laboratory hopes to sponsor research in techniques which can enable a missile guidance system to recognize an object or area as being a suitable target without prior knowledge of exactly what the target looks like, possibly on the basis of its pattern of electromagnetic radiation.

• **Small, narrow-beam antennas:** New antenna techniques, which will permit small antennas to achieve narrow bandwidth in order to give satellite or space vehicle radar good definition is another Weapons Guidance Laboratory requirement.

• **Vertical reference:** WADC's Flight Control Laboratory is seeking a good vertical reference which is insensitive to vehicle accelerations. The Laboratory is sponsoring a program at Collins Radio Co. which has developed a fundamentally new approach to vertical determination that promises to be entirely unaffected by vehicle acceleration.

• **Sunlight communications:** WADC's Communication & Navigation Laboratory plans to investigate techniques for modulating sunlight and using it directly for space communications, instead of using relatively low-efficiency solar cells to convert sunlight into electricity, then using electricity to power a relatively low-efficiency radio transmitter.

Special Skills Needed

Investigations of this sort, and the breakthroughs required for space technology, promise to place an even higher premium on engineers with a strong background in basic science. As one WADC official puts it: "We are scraping the barrel in trying to extend present radar and infrared techniques to many of the problems of space exploration. What we need are fundamentally new approaches."

Engineers who have the uncommon ability to simplify equipment design, a marked reversal of the design trend of recent years, also should be much in demand. This includes both circuit

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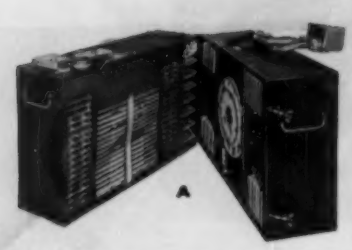

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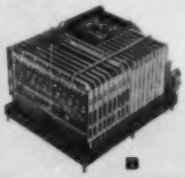

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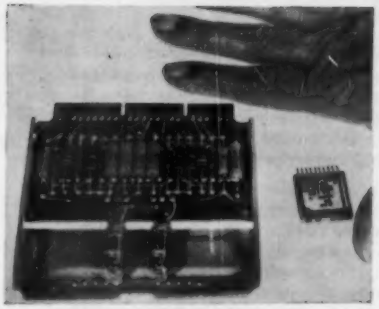

MICRO-MINIATURE construction for use in space vehicles is illustrated in comparison of new Hughes Aircraft flip-flop circuit (right) with equivalent circuit constructed using conventional techniques.

development engineers and mechanical designers.

Major strides have been made during the past decade in avionic equipment miniaturization, largely due to development of smaller components and improved packaging techniques. But the 10- to 100-fold size and weight reduction needed for satellites and other space vehicles will be difficult to achieve through extensions of past progress because components have almost reached the point where further size reduction will require tweezers and microscopes for unit assembly.

This explains current widespread military and industry interest in the concept of "molecular electronics"—the fabrication of avionic subassemblies and circuits by electro-chemical processes whereby the components are no longer recognizable or handled as separate devices. Related to this is the search for fundamentally new principles which will enable a new type of element to perform a function that formerly required different components interconnected to form a circuit.

Current programs in molecular electronics, such as the vacuum-deposition process of Varo Manufacturing and Servomechanisms (AW June 2, p. 64), and the more conventional micro-miniaturization efforts of Diamond Ordnance Fuze Laboratory, Hughes Aircraft, American Bosch Arma and others, suggest that manufacture of avionic subassemblies in the future will take place in a facility that bears more resemblance to a chemical-physics laboratory than to the familiar electronic manufacturing facilities of the past.

Although the reliability and quality control programs for avionics used in ballistic missiles is an order of magnitude more rigorous than those formerly applied to other missile and aircraft equipment, the reliability required for space vehicles will be at least an order of magnitude higher.

This means considerably more testing and quality control efforts from the start of development through manufacturing. This, coupled with the increased amount of engineering and development content in avionic equipment for space vehicles, suggests that the demand for scientific manpower will continue to increase.

Most avionics manufacturers in the past have viewed development as the admission price for subsequent production programs. Majority of the military sponsored developments are contracted for on a cost-plus-fixed-fee basis. But after deducting customary business expenses which are disallowed by government auditors, the return is considered less than adequate to sustain most companies, particularly if they own their own facilities.

In the past, industry has complained frequently about the profit margins allowed on defense business, sometimes with justification, sometimes when the real problem lay in inefficient company operations. Present trends should strengthen industry's case, but with the defense budget already considered inadequate to meet the potential threat, there is no indication of early relief.

This suggests that avionics manufacturers must thoroughly re-examine their structure and operations, and make changes where necessary to adapt better to the coming business environment.

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GPL combined guidance

A.I.D. Navigation Systems

Combining state-of-the-art equipment in several fields to create new and superior systems for aircraft and missile guidance is still another GPL capability. One case in point is GPL's Astro-Inertial-Doppler A.I.D. navigation system—a stellar monitored, doppler tuned and damped inertial system—in which each element refines the others, and the system as a whole provides far greater inherent accuracies.

A.I.D. and other combined guidance and integrated systems now under development at GPL are particularly significant because they utilize *existing* systems and elements, *existing* components of proven reliability and accuracy, *existing* techniques for manufacture and maintenance. Yet continuing study of progress in the state of the art and continuing study of new system concepts keep these systems as advanced as the aircraft and missiles they will guide.

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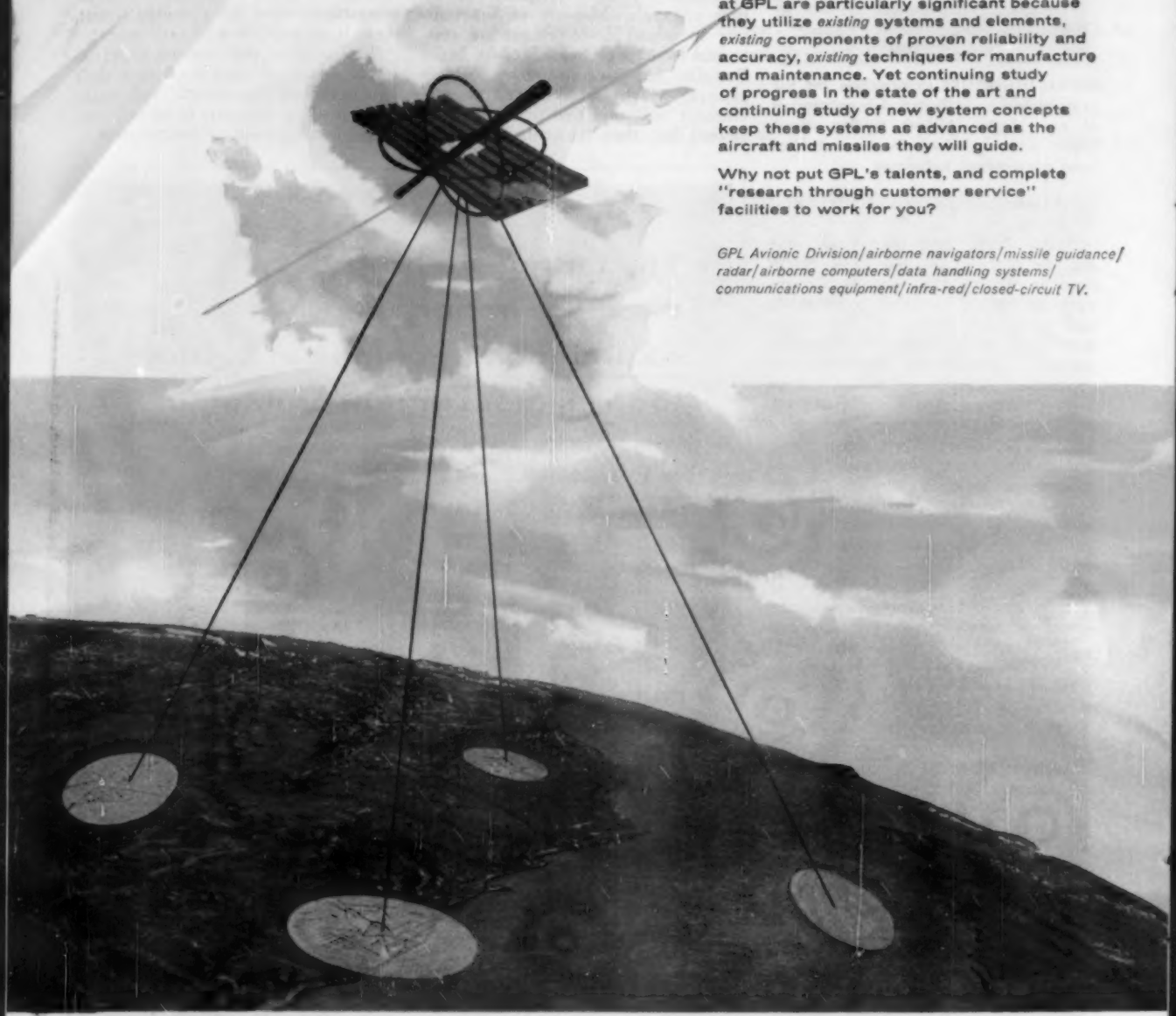

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FAA Plans Close Monitoring of Programs

Washington—Largest single program to be funded out of the $45-50 million which the Federal Aviation Agency hopes to obtain for research and development in Fiscal 1960 will be the automatic data processing and display equipment effort now under way at General Precision Laboratory.

In addition, FAA is seeking approximately $14 million to expand facilities and outfit its new National Aviation Facilities Experimental Center (NAFEC) in Atlantic City, N. J.

Funds sought by FAA for research and development, approximately twice the figure for Fiscal 1959, also will enable its Bureau of Research and Development (successor to the Airways Modernization Board) to sponsor programs in a number of other important areas across the broad spectrum of its assigned responsibilities. These areas include:

• **Air collision avoidance techniques:** FAA plans to sponsor a number of programs to search out and investigate promising techniques for airborne proximity warning and/or collision avoidance devices. Emphasis will be on determining potentialities and shortcomings of each technique, rather than developing end-use hardware, according to L. C. Wright, director of development for FAA's Bureau of Research and Development (BRD). The Bureau has not only strengthened its own permanent staff in this air collision problem area, but also has asked each of the military services to loan its own experts on a temporary assignment in order to investigate every possible technique which might find use in solving the air collision problem.

• **Instrument approach and landing:** Another major Bureau effort will go into improving existing instrument approach systems, testing available instrument landing systems, and sponsoring development of improved instrument approach and landing systems. At its Atlantic City facility, the Bureau plans to evaluate an improved ILS localizer antenna and a new flush-mounted glide slope antenna, developed by Ohio State (AW Oct. 27, p. 61). These are developments which could provide very early improvement in existing approach equipment. In October, the Bureau plans to begin tests of the Bell Aircraft AN/GSN-5 ground-based automatic landing system as well as several airborne flare-out adaptors in an effort to evaluate relative merits of each approach. Shortly afterward, the Bureau hopes to receive a new automatic instrument landing system, developed by Gilfillan, which employs new radar techniques that may permit flexible approach and landing paths for a wide variety of different aircraft types.

• **Aviation weather system:** Working with the Air Force and the Weather Bureau, FAA plans to apply computers and automatic data collection and processing techniques to improve speed and accuracy of gathering and disseminating aviation weather data. Although final details have not been worked out, this promises to be a major development area of interest to avionics manufacturers.

The foregoing represent only the major programs and there will be many small development and study programs of interest to avionics companies.

With more than 100 projects and tasks actively under way, and a total of several hundred planned, the Bureau has set up a tight system of monitoring and control to minimize any slippage from the rigorous timetable by which FAA is working. Program control, headed by Donald W. Dunn, applies both to Bureau personnel and to outside contractors.

For example, there are 16 distinct steps from the time the Bureau establishes a project or task requirement until it becomes a firm contract. When a new requirement is established, a target date is set for the selection of a contractor and contract award, with corresponding dates for each of the intervening steps.

In the central program control room, Dunn and his associates post the latest status of every program on a device known as "the control tower." This is a series of six large aluminum panels mounted on a rotating pedestal. Each panel can be rotated within its own frame so that data can be posted on both sides, providing a total of 12 sides.

Once a week each of the program status panels is photographed and offset copies are sent to each of the division chiefs as well as to individual project engineers.

Once a requirement has reached the contract stage, another type of data is assembled and posted to display program status. Every month, each Bureau contractor is required to submit a report which includes the following data:

• **Estimated overrun,** if any, an cost-plus-fixed-fee contracts.

• **Total contractor expenditure** and commitment for the next 30 days, This shows how much FAA will need in the way of funds to reimburse the cost-plus contractor.

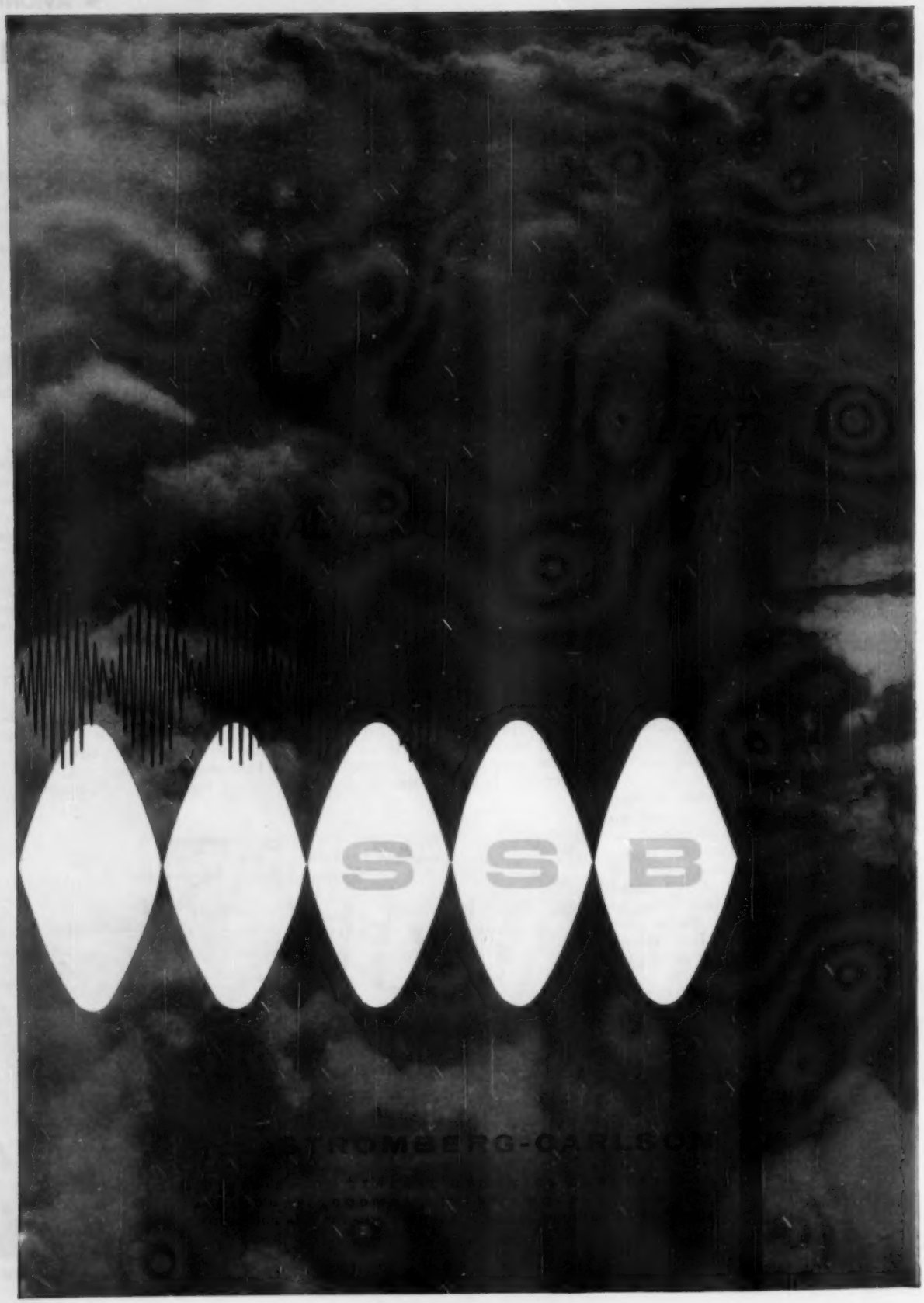
• **Total paid to contractor** to date.

• **Per cent of work completed.** This figure is provided by both the Bureau project engineer and the contractor. The figure posted on the control tower is the project engineer's estimate.

• **Estimated completion date.**

Total funds paid to contractors are

MOCKUPS of traffic controller consoles for use in a new data processing system being developed by General Precision Laboratory is slated for initial tests this fall.



Circle Number 90 on Reader-Service Card

A new approach to Single-Sideband radio by Stromberg-Carlson...

...greater power output, less power input with a smaller volume.

The SC-900A digit-tuned Single-Sideband transceiver marks a significant advance in the state of the art.

The SC-900A is designed for both vehicular and fixed point-to-point communications—adaptable to rack mounting and back-pack—meets full military requirements.

Provides 28,000 stabilized channels from 2 to 30 megacycles, with a transmitted peak envelope power output of 100 watts.

Receive input power: 50 watts. Average transmit input power for voice: 150 watts.

Available soon.

S-C GD

FAA charts for monitoring progress, spending on research and development programs includes funding schedule displayed here.

watched very closely, Dunn says, to be sure that the agency fully utilizes all of the funds allocated to it.

For major programs, like the General Precision Laboratory data processing system and the Aircraft Armaments traffic control simulator, completion date for each significant milestone of the program is estimated at the start and the contractor's progress along these milestones is posted in considerable detail. Once a month the contractor, Bureau project engineer and agency officials get together, go over the program's current status, milestone by milestone.

Although BRD officials recognize that measuring progress in advanced development programs of the type it sponsors can never be extremely precise, the control program indicates that it intends to ride herd on its contractors to avoid the severe slippages which plagued its predecessor agencies.

First Anti-Missile Work Begins; Military Directs Defense Efforts

By James A. Fusca

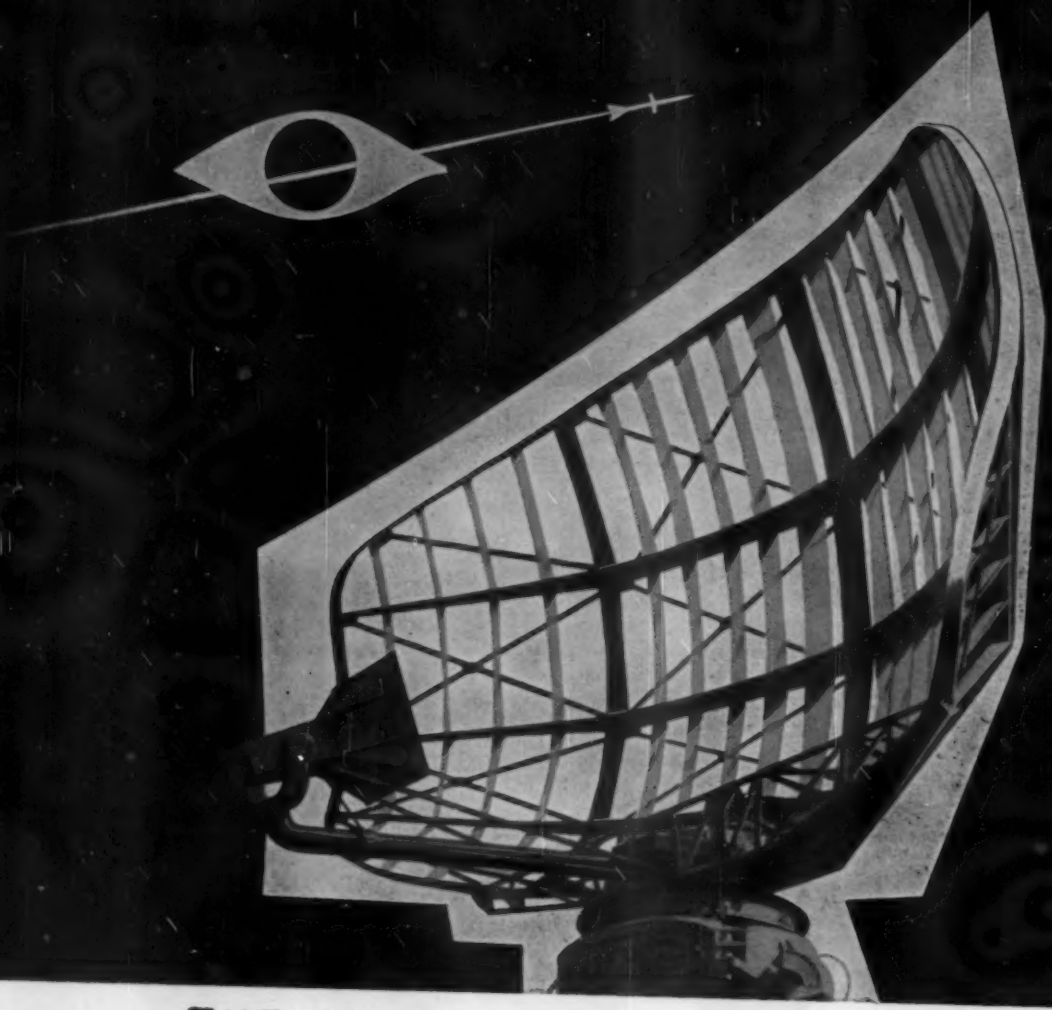
New theoretical approaches to the problems of defense against ballistic missiles evolved during the past year will be competing for available funds with missile detection and anti-missile programs already in development during military budget battles this year. All three services will be participating.

Under the Department of Defense reorganization that took place early last year, the newly-created Advanced Research Projects Agency was assigned responsibility for the missile defense program and control over the projects funded by the individual services. Although ARPA is awarding some small study contracts, most of the missile defense effort continues to be directed through the services.

Present status of the major missile defense programs is approximately as follows:

• **Air Force.** USAF is developing and installing the Ballistic Missile Early Warning System (BMEWS) for the purpose of providing the maximum possible reaction time by the U.S. in case of attack. Also under the direction of ARPA, the Air Force is conducting studies of problems related to anti-missile missile systems, but these studies do not call for production of hardware.

• **Army.** Army is developing its Nike Zeus anti-missile missile system for active defense of the continental U.S. against ballistic missile attack. Nike Zeus is an outgrowth of the Nike Ajax and Nike Hercules missile family. Additionally, the Army and ARPA have just begun a downrange experimental project called DAMP—Downrange Anti-Missile Measurement Project—to gain test data on missile detection and tracking during the terminal phase of the flight. A third Army project for the defense of Army field forces by a transport-



••••••THE WHITES OF THEIR EYES••••••

The whites of the enemy's eyes are now visible half-way around the earth... thanks to technological contributions from Stavid in the area of long-range ballistic-missile detection and high-power radars.

When it becomes operational, the high-power Early-Warning Air-Search Radar now being developed by Stavid will greatly extend the vision of ships in our DEW-line defense network. Innovations in radar transmitter design will provide a compact, high-power system, achieved through new techniques in side-lobe suppression and antenna gain.

Every new advancement in long-range detection finds Stavid in the vanguard, working with exotic as well as state-of-the-art techniques.

OTHER STAVID PROJECTS INCLUDE:

- Sferics Locating System AN/FMS-3
- Electronic Beam Steering Sub-system
- Antenna System AN/BPA-6

Antenna systems engineer, H. W. Kasper, has 7 years' experience in antenna and microwave development. His work at Stavid includes antennas for air search, guidance, telemetering and airborne bombing.

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Outstanding engineers and scientists are invited to inquire into opportunities on Stavid's advanced systems engineering teams.

able anti-missile system, called Plato, is no longer being funded and probably will terminate by June.

• **Navy.** Although the Navy has not been involved in any of the large anti-missile programs to date, it has been exploring for some time the use of its Talos shipboard-to-air missile as an anti-missile missile. With new missile detection and destruction techniques now being explored, the Navy is striving to become the nation's first line of missile defense.

Air Force Projects

The Ballistic Missile Early Warning System being developed by the Air Force under ARPA direction for the earliest possible detection of Soviet missiles launched against the U. S. will under present plans eventually consist of three sites:

• **Thule, Greenland.** Construction here began last summer. The target date for this site to become operational is believed to be in the spring of 1960.

• **Fairbanks, Alaska.** Contracts for construction at this site have just begun to be let. Probable target date for the site to become operational is in the fall of 1960.

• **Prestwick, Scotland.** To function with maximum effectiveness, BMEWS requires the installation of a third site. Air Force planners consider the best location would be in the vicinity of Prestwick, Scotland. The U. S. State Department has requested permission from the British Foreign Office for this installation but, at present, the British are reluctant to allow it. The reason is that it would make this area a prime target in the event of war.

Each of the BMEWS sites will employ four detection radars and three tracking radars installed in seven buildings laid out in a semicircle about a mile long and connected by weatherproof passageways large enough to accommodate maintenance vehicles.

Four Radars

The purpose of the four 3,000 mi. detection radars at each site is to scan a fixed azimuth sector of the air space over the Soviet Union to detect intercontinental ballistic missiles as their trajectories bring them above the radar horizon. Each radar will sweep an azimuth sector of about 30 deg. to obtain a total azimuth coverage of approximately 120 deg.

These detection radars will use split beams, vertically offset by a few degrees, which will be swept back and fourth horizontally at high speed by means of an organ-pipe antenna scanning system. From azimuth angle of interception of a detected missile, angular distance between beam interceptions, and time of travel, a computer

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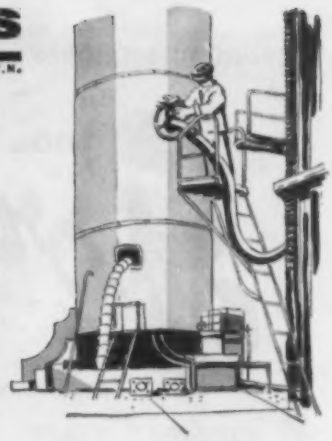
for liquid oxygen and rocket fuels



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• **Will not respond to wetting or splashing**

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Explosion-proof version for ground installation

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Quartector Liquid Level Detection Systems, with no moving parts to stick or freeze, detect liquid levels to within ± 1/32" with a response time of less than 40 milliseconds. Operating temperature range is from −425°F to +120°F.

Quartector systems and instruments are designed for *bulk liquid applications* such as fuel tanks in missiles or other types of pressure vessels, and for *pumping applications*. A real-time indication is provided when the liquid has reached pre-selected points in pipe lines or tanks.

The Quartector sensing element is a piezo-electric quartz crystal mounted in a probe or submersible sensor unit. Circuitry consists of a four stage transistor amplifier with a transistor detector circuit in the feedback loop, and an output control relay. When the crystal is in gas, it is free to vibrate at its natural frequency, and oscillation is sustained. When the crystal is submersed in liquid, however, its motion is damped, signal output drops, and the output control relay is de-energized.

Splashing, bubbles, and wetting do not affect the sensor. Liquid indication is given only when the crystal is completely surrounded by liquid. Safety features include a fail-safe and function test procedure. Write to Trans-Sonics, Inc., Dept. 7, Burlington, Massachusetts, for Technical Bulletin 1900.

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...as basic as an ALTITUDE SWITCH		or	as advanced as a MACH NUMBER SWITCH
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	1.25 oz	Weight	1.4 lb
	—3,000 to +80,000 ft or .4 to 50 psia	Actuation Setting Range of Tested Available Models	Mach .75 to Mach 3.00
	SPDT 18-30 VDC, 2.5A Ind.	Electrical Rating	SPDT 28 VDC, 2.5A Ind.
	—65 to 180F —65 to 275F —65 to 400F	Temperature Ratings Available	—65 to 212F
	5-500 CPS	Vibration Ratings up to 10G and Higher	5-500 CPS
	MIL-E-5272A	Explosion Ratings to Specification	MIL-E-5272A
			A Gorn achievement in pressure-switch engineering, this absolute pressure ratio switch performs with rugged dependability and broad-range versatility. Actuation and reactuation band setting adjustable for response at specified ratios and values of Mach numbers from .75 to 3.00, at altitudes up to 70,000 ft. Stable under severe vibration... available from present production. Proved by thousands of hours service on high performance jet aircraft including the **Chance Vought CRUSADER.**

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Circle Number 92 on Reader-Service Card

CAPABILITIES FOR DEFENSE

will compute a rough approximation of the trajectory to aid acquisition by a tracking radar.

The tracking radars at each site will have two purposes:

• **Identification.** Tracking radars must attempt to identify a detected object as a missile rather than a meteorite or falling satellite.

• **Impact point.** These radars must also provide tracking data to the computer for computing point of launch and point of impact.

The complex scanning system to be employed with the 90 ft. parabolas of the tracking radars will enable them to be used as detection radars when one is out of service. Range of the tracking radars also will be about 3,000 mi.

Under the direction of ARPA, the Air Force also is conducting studies of anti-missile missile system problems with the purpose of developing advanced system concepts. USAF is reported to believe that some of these studies have reached the point where hardware would be funded.

The Army has been assigned by ARPA to develop its Nike Zeus anti-missile missile system, apparently because at the time of assignment hardware existed for the Nike Zeus program, none for the Air Force program. Under present budget allowances the Army expects to have the system operational by 1964, but it is pressing for additional funding to speed the program for a 1962 operational date.

Both the Air Force and the Navy are arguing against additional funds for Nike Zeus, claiming that some of the newer approaches make the Nike Zeus concept obsolete.

For the probable purpose of gaining experimental data for the Nike Zeus program, the Army with the joint sponsorship of ARPA has undertaken the Downrange Anti-Missile Measurement Program. As a part of this program, a cargo vessel, the S. S. American Mariner, has been refitted and equipped with radar and infrared detection and tracking and telemetry equipment.

The vessel will be stationed downrange near the re-entry point of experimental missiles fired from Cape Canaveral. By detecting and tracking missiles during their terminal phase, test data will be gathered in an attempt to specify missile characteristics during that portion of the flight that the Nike Zeus system will be acquiring, tracking, and launching an intercept missile against it.

The Army did have under development the Plato system, a transportable system for defense of Army field forces. According to a recent Department of Defense announcement, however, Plato has received no funds since the end of Fiscal 1958, last June 30, and no further development is planned.

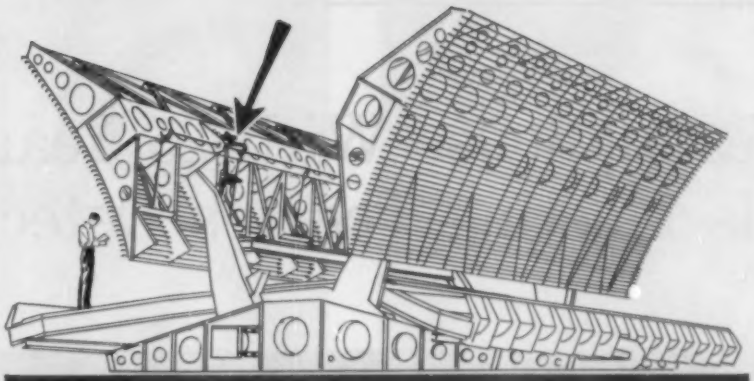

Photo courtesy Western Electric

R2552 LINEATOR exemplifies Airborne capabilities in large special actuators. Installed in pairs, units control tilt and shape of DEW Line antenna reflectors, must operate in temperatures from —65 to +130°F.

Airborne large special actuators used for DEW Line antenna control

Airborne large special actuators are being employed today in a diversity of applications, both air and ground. On the DEW Line, for example, pairs of Airborne R2552 LINEATOR actuators are used to control the tilt and shape of AN/FPS-19 antenna reflectors. Environment in this instance involves extreme temperature and humidity conditions and these call for a high order of mechanical and electrical reliability.

The R2552 typifies Airborne's capabilities in developing large special actuators—linear or rotary. And where requirements are not unique, we also offer a line of modular-type actuators, originated by Airborne to simplify design and specification. Write for further information.

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2. Speed at rated load of 400 lb.: .3 in./sec.
3. Ambient temperature: –65 to +130°F. (–80°F. non-operating). Relative humidity: up to 100%
4. Design incorporates 2 limit switches and 4 intermediate position switches, plus synchro position transmitter.

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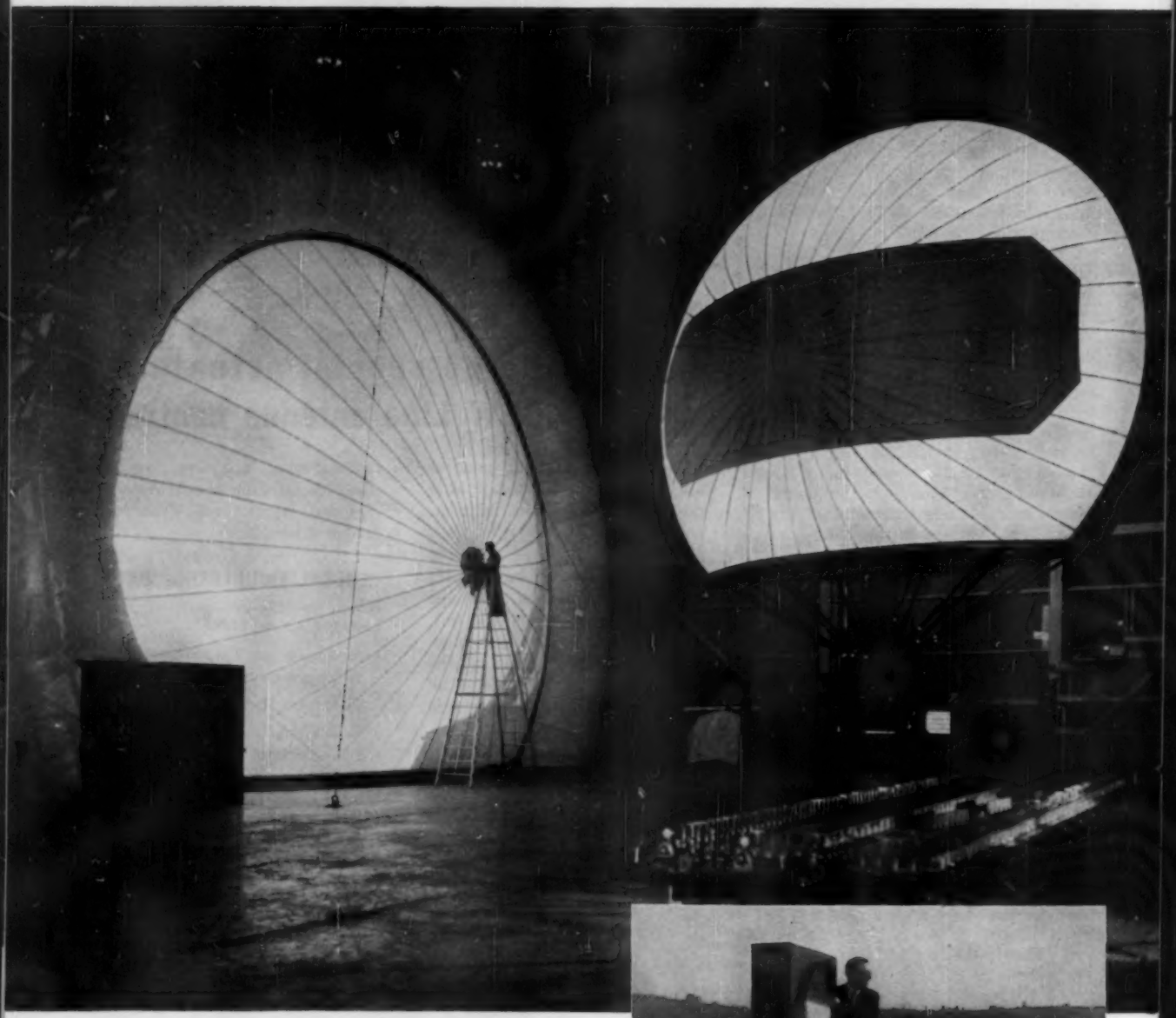
CAPABILITIES FOR DEFENSE

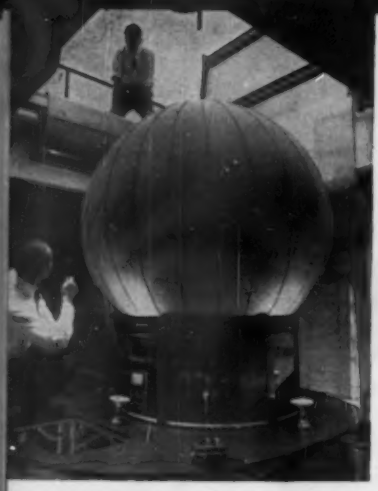
Westinghouse With 25 Years Of Leadership Is Meeting Today's Detection Problems



Westinghouse has been in the radar field since 1933. In that year, Westinghouse engineers, pioneering in radar techniques, detected automobiles on a highway by beaming ultra short radio waves experimentally off a rooftop of the Westinghouse East Pittsburgh Plant (illustrated at right).

Westinghouse has delivered over 35,000 radar sets . . . and continues its role today in ground and shipboard radar for air defense and tactical missions, airborne radar for reconnaissance, AEW, mapping, ASW and missiles, and such specialized areas as pulse-doppler, infra-red, ECCM, and 3-D radar techniques.

Shown is one of the most significant advances in the field of tactical military equipment—the lightweight, highly mobile Paraballoon® Antenna, developed at the *Electronics Division*.



NON-ROTATING ANTENNA. A new kind of radar antenna, the Helisphere is considered a possible forerunner of those to be used for powerful antimissile radars of the future. The antenna, pictured at the Westinghouse *Research Laboratories*, produces a rotating radar beam without rotation of the antenna structure itself.

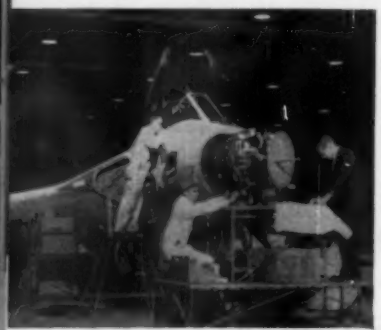
INFRA-RED. Westinghouse has been actively at work in infra-red research, design and development since World War II. Extensive programs are now being conducted for applications of infra-red techniques to present and future military requirements as well as the space age. Pictured is an infra-red seeker, newly designed at Westinghouse *Air Arm Division*.

BIGGEST RADAR TUBE. Heart of the longest range shipborne radar ever put in service, a magnetron tube nicknamed "Big Maggie" was developed at the Westinghouse *Electronic Tube Plant* at Elmira. "Big Maggie" delivers over 10 million watts of peak power, enough to search out enemy planes over 400 miles away.

MOLECULAR SYSTEMS. A new, low-noise amplifier developed by scientists at Westinghouse *Research Laboratories* for *Air Arm Division* application. This two level solid-state maser is one aspect of a broad Westinghouse program of molecular engineering for radar and other electronic systems of the future.

WORLDWIDE SERVICE. Wherever Westinghouse radar is in operation . . . land, sea and air . . . field engineers of the *Electronics Service Department* assist and instruct in the operation and servicing of radar manufactured by the *Air Arm* and *Electronics Divisions*. Graduate engineers provide this Westinghouse service the world over.

COMPLETE TEST FACILITIES. Radar undergoes composite test at *Electronics Division*. A complete computer facility is available here and at *Air Arm Division*. Included are IBM 704 and large REAC, together with all environmental, shock, vibration and other test equipment necessary for the development of present and contemplated land, sea, air and space-borne systems.



200-MAN FLIGHT TEST FACILITY. Engineers at *Air Arm Division* install Aero 13-F radar and computer, latest and most advanced radar built by Westinghouse. Flight test facility includes over 200 people and all facilities necessary to completely service, instrument and test avionic equipment in Westinghouse owned and bailed aircraft.

For additional information on detection systems and applications at Westinghouse, write to:

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SIKORSKY S-62 turbine powered helicopter tests amphibian hull in Long Island Sound.

Helicopters

It's another aviation first for Bell . . the first full in-flight conversion by a tilting-rotor fixed wing aircraft. Bell's XV-3 convertiplane made its metamorphosis in mid-air, to change from a helicopter to an airplane and back to a helicopter. Altitude was 4,000 feet, speed 115 knots, change-over was smooth in both operations. It took only 15 seconds for the XV-3 to make aviation history. With its ability for vertical take-off and landing plus the prime capabilities of speed and a wider operational radius, the convertiplane will give the Army a new weapon, tailored to today's tactical and logistical needs. Bell is developing the XV-3 for the U. S. Army under contract administered by the U. S. Air Force. The 4-place experimental model is a research prototype for future development into larger transport convertiplanes that hold vast possibilities for both military and commercial applications. Full conversion of the XV-3 is a major step toward this goal.

BELL'S XV-3 GOES FULL TILT

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KAMAN H-43B HUSKIE AND FIRE RESCUE KIT

Helicopter Market Hits Transition Lull

By Robert I. Stanfield

Big commercial market for helicopters should come into being in 1960, with operators taking advantage of all-weather instrumentation and turbine-powered rotorcraft. Last year—beginning a period of declining sales and government austerity that is expected to continue through 1959—the transition from piston to turbine began to appear.

Last year also marked a spurt in research and development of VTOL testbeds—some company financed, most supported through Army-Navy-Air Force funds. Economically, much is yet to be done—particularly in payload/weight ratio—to adapt these vehicles to commercial operation. On the military side, flying crane-rescue-transport VTOL capabilities are highly desirable.

Despite the fact that helicopter-producing firms are on the increase, there is expected to be a consolidation to fewer and bigger companies. Five major manufacturers currently produce most commercial helicopters. Militarily there are about 20 helicopter companies competing for service orders.

Of special significance is the increasing number of companies engaged in VTOL development, which eventually will mean tangible military hardware contracts. About 19 such firms include most helicopter manufacturers plus companies that primarily had specialized in fixed-wing production—Fairchild, Grumman, Lockheed, McDonnell—and newcomers, such as Collins Radio and Chrysler Corp.

Commercially, there are about 48 route petitions now before the Civil Aeronautics Board of persons wanting to get into the helicopter business. Post Office Department also has over 75 applications from cities requiring helicopter service. In the event turbine-powered aircraft require limited or no subsidies, this could produce a production breakthrough.

Last year showed a 37% increase in the number of helicopter operators in North America as against 1957, and a 37% increase in the number of helicopters, according to the Helicopter Council. More than 100 rotorcraft are being operated for executive and company use, more than 500 by commercial operators, 25 by the three certificated airlines and 29 by 12 state and municipal agencies.

Helicopter operating industry now grosses about $35 million annually in the United States and Canada.

Today's big commercial transport helicopters carry 12 to 15 passengers at costs of roughly 20 cents a passenger mile.

By comparison, a 25-passenger turbine-powered helicopter is expected to generate half this cost.

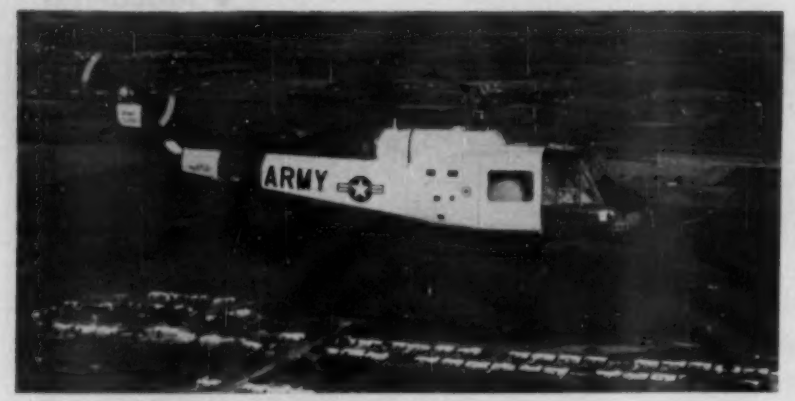
Commercial orders placed with four major companies during 1958 covered 178 units at $19,863,000. By comparison, during 1957 three helicopter firms received orders for 251 units totaling $28,074,000.

Last year's traffic figures for the three certificated helicopter airlines are as follows:

- **Chicago Helicopter Airways:** 109,136 revenue passengers carried 1,997,000 revenue passenger miles. Load factor 37.3%. Mail carried totaled 17,614 revenue ton miles. Total revenue ton miles: 208,189.
- **Los Angeles Airways:** 31,663 revenue passengers carried 1,181,000 revenue passenger miles. Load factor 53.1%. Mail carried totaled 48,005 revenue ton miles. Express, 22,527 revenue ton miles. Total revenue ton miles: 183,256.
- **New York Airways:** 91,114 revenue passengers carried 1,761,000 revenue passenger miles. Load factor 44.8%. Mail carried totaled 17,823 revenue ton miles. Express, 10,378 revenue ton miles. Freight, 6,127 revenue ton miles. Total revenue ton miles: 202,610.

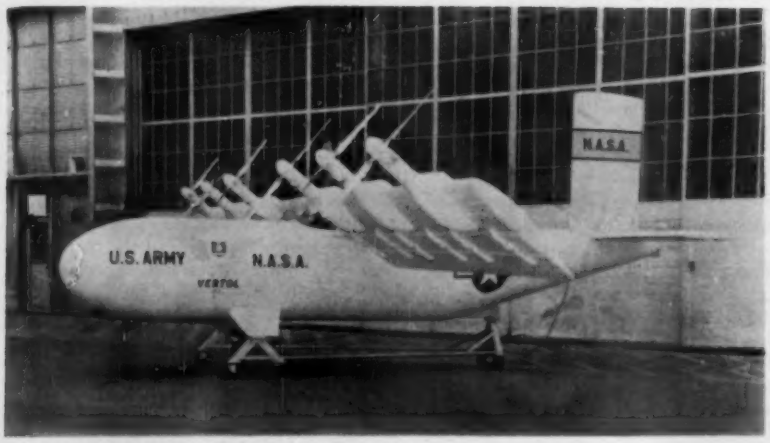
For the three airlines, per cent of revenue earned to available ton miles was as follows: Chicago, 28.5%; Los Angeles, 58.4%; New York, 44.6%.

Some basic advantages of the turbine-powered helicopter include good payload/weight ratio, power, speed. "No matter how fast fixed-wing aircraft fly between 200-mi. cities, the helicopter is the best bet because of the time consumed between city and airport," Michael E. Gluhareff, Sikorsky engineering manager, told AVIATION WEEK. Speeds of 200 kt. are "around the



BELL HU-1 WITH ARCTIC PAINT

REPUBLIC-BUILT SUD DJINN



VERTOL TILT-WING/VECTORED SLIPSTREAM MODEL

corner" with practical payloads, he said.

Sikorsky, which had limited itself to research, development and production of the true helicopter, only recently established a new Advanced Configurations Research Section to delve into advanced systems of VTOL flight, in addition to rotary wing improvement (AW, Feb. 2, p. 66).

Helicopter Developments

Past year's helicopter developments included:

• **Sikorsky HSS-2,** designed to meet U. S. Navy requirements for improved aircraft and techniques in anti-submarine warfare. Twin-turbine powered amphibian is expected to make its first flight this month. It will be fitted with four torpedo racks, and will have nuclear weapons capability.

Other Sikorsky projects include the S-60 flying crane helicopter of six-ton cargo capacity, the first step in a future family of even larger flying cranes including a turbine-powered model of 20-ton capacity; the S-62 turbine-powered 10-to-12 passenger helicopter; a commercial version of the S-61 (Navy's HSS-2), a seven-bladed rotorcraft powered by three General Electric T58 turbines with a cruise speed of 150 kt. and range, with 28 passengers, of 300 naut. mi.

• **McDonnell Model 120,** triple-turbine powered lightweight helicopter aimed at providing Army ground troops in battle areas with a versatile, low-maintenance flying crane. This helicopter can carry about a ton over 80 naut. mi. at more than 100 mph. Crane configuration permits attachment of 105 mm. howitzer or jeep-type vehicles. Rotor tip burners are supplied by AiResearch GTC-85-36 gas turbine air compressors.

• **Sud Alouette,** marketed by Republic Aviation, which is proving acceptable to the offshore oil industry, according to Robert Suggs, president of Petroleum Helicopters, Inc. Reason: speed of 90 mph. on 70-mi. flights; fuel availability (kerosene is a common item) for its turbine engine, and aircraft availability which has been averaging 88% for Petroleum's two Alouettes.

Republic also markets the French Sud Aviation Djinn, two-place rotor-tip jet which operates on the same principle as a rotary lawn sprinkler. Turbomeca Palouste IV turbine engine generates a speed of 81 mph.

• **Kaman H-43B,** incorporating the Lycoming T53-L-1A turbine, was rolled out last December. It is keyed primarily to the Air Force concept of employing rotary wing aircraft throughout its commands as crash-rescue vehicles to reduce loss of flight personnel. USAF has contracted for 74 of these helicopters through fiscal 1959.

Company also is grooming an entry for the civilian helicopter market, the

NEW YORK AIRWAYS 15-passenger Vertol 44B at West 30th St. heliport, Manhattan.

PASSENGERS from New York Airways' Vertol 44B board bus for short trip to terminal.

HUGHES YHO-2HU is designed for Army observation, liaison and training missions.

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There are important positions available in these small, independent engineering groups at Bendix-Pacific for high level engineers from senior grade and up. Bendix-Pacific is particularly interested in strong, analytical engineers who have the calibre and capabilities to advance into systems engineering programs.

Please write W. C. Walker your qualifications or fill in the coupon and mail it today.

W. C. Walker, Engineering Employment Mgr.
Pacific Division, Bendix Aviation Corp.
11600 Sherman Way, North Hollywood, Calif.

I am interested in this engineering field____
I am a graduate engineer with____degree.
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AIRCRAFT POROUS MEDIA, INC.

leads in filtration

for airborne, test and ground service equipment

How APM established position of leader in airborne filtration

As the only filter manufacturer with a fully integrated staff for airborne filtration, APM is the unqualified leader and has established industry-wide standards for:

Reliability	Testing
Engineering	Research & Development
Service	Production

Reliability

First with controlled maximum pore size; with zero media migration; 4500 psi differential rated elements, for use without by-pass valves; differential pressure indicator.

Engineering

A complete staff working exclusively on airborne filtration includes the following engineering skills:

Mechanical	Chemical
Filtration	Textile
Metallurgical	Contamination
Colloid Chem	Environmental Test
Microscopic	Vibration

Testing

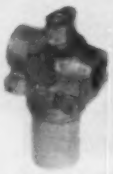
Thirty test stands operate on all "airborne" fluids. Pumping facilities up to 60 h.p. and 5000 psi with max. flow of 120 gpm and temp. range of −100°F. to 600°F. Equipment for impulse testing, vibration, microscopy, ultrasonic cleaning.

Research & Development

The first rigid cleanliness standards were developed and maintained by APM R&D. APM engineers were first to produce porous material for transpiration cooling and boundary layer control; airborne filters operating up to 900°F.; 3 micron absolute filter; built-in differential pressure device. RIGIMESH® filter element is a product of this R&D.

Rigimesh® Filters

Typical of APM R&D are RIGIMESH Filters for use with hydraulic fluids, lube oils, fuels, air, helium, nitrogen, hydrazine, etc. APM stocks 2, 5 and 10 micron filters; up to 150 micron on special order. Elements are all stainless steel, have high dirt capacity with long service intervals; are cleanable, permanent. Capacity: 0.1 to 5000 gpm, in connection sizes from ¼" to 14". To 5000 psi service, higher on special order. Optional features include by-pass valve; without valve, but with element reinforced to withstand 4500 psi differential pressure; with differential pressure indicator. (For further information, send for Bulletin A-1081.)



Differential Pressure Indicator

Detects clogging of filters, nozzles, orifices, other flow restrictors. Reports excessive pressure drop in hydraulic or fuel system. Inlet pressure to 5000 psi; differential pressure from 2 to 100 psi. Temperature range −65°F. to +275°F., higher on order. Aluminum, Stainless Steel with Alnico magnets. (For further information, send for Bulletin A-109.)

APM Production Capabilities

The versatility of APM filters is indicated by the fact that on one single aircraft there are 16 applications. APM filtration engineering has been applied in operation and service of the following airborne equipment:

Missiles

Falcon	Sparrow	Bullpup
Hound Dog	Zuni	Subroc
Bomarc	Jupiter	Hawk
Polaris	Talos	Nike Hercules
Tartar	Terrier	Atlas
Honest John	Redstone	Thor
Titan	Vanguard	

Aircraft

707	880	600
1649	DC8	F27
Electra	C130	Jetstar
B52	F102	F106
B58	F104	P6M
Voodoo	F100	T2J
F105	119	S61
	S62	

Engines

T58	J59	J34
J6W18	J75	and many others

You are invited to request our interesting 'Poroscope", a regularly published bulletin on filtration news. Our Engineering Department will promptly acknowledge any inquiry with your filtration problem.

AIRCRAFT POROUS MEDIA, INC.

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GLEN COVE, NEW YORK

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K-17 pressure-jet-powered two-man helicopter designed for low cost field operations and simple maintenance. It is being investigated by the Army. Its HU2K, designed for the Navy and powered by the General Electric T58, is due for first flight this year.

• **Bell HU-1,** designed from scratch as a turbine-powered utility helicopter for the U. S. Army. This light, 3,834 lb. rotorcraft exceeds in all respects initial Army requirements calling for a helicopter that would cruise at 100 kt., climb at 1,500 fpm., and deliver an 800-lb. payload over a 100 naut. mi. radius. Power is supplied by the Lycoming T53-L-1.

• **Vertol Model 107,** 160-mph. multiturbine transport helicopter, the airline configuration of which the company expects to have ready for delivery in 1961. The helicopter will normally seat 23-25 passengers. Its military counterpart, 10 of which have been ordered by the Army, will be powered by twin General Electric T58s; three of the YHC-1s will be powered by Lycoming T53s.

• **Doman Model D-12,** two-place turbine-powered helicopter designed for a top speed of 160 mph., is expected to sell for about $12,000. Preliminary engineering has been completed on the project, based on a design study made by Doman for the Army. Powerplant planned is the Allison 250-C1 turbine, with engine weight under 100 lb.

• **Hiller UH-12E** executive and utility helicopter, which lists at $59,950, is powered by the new Lycoming VO-540-A1A six-cylinder engine delivering 310 hp. at takeoff. Maximum cruise speed at 75% power, is 87 mph. Gross weight is 2,700 lb., providing 528 lb. for passengers or cargo. Range is 185 mi.

• **Omega BS-12A** twin-engine utility flying crane is in production. The first has been purchased by the Massachusetts Department of Public Works. Payload is 1,050 lb. Powerplants are Lycoming A-540F1As of 260 hp. each. Company also is building a small, two-place, utility helicopter, the Blue Jay.

VTOL Developments

Developments in VTOL aircraft during the year included:

• **Lockheed CL-379,** a VTOL-STOL turboprop reconnaisance aircraft which the company has proposed to the Army. It would be equipped with Lycoming T53 engines of about 1,000 shp. each. Vertical lift would be achieved by increasing wing incidence about 20 deg. Flap system would provide moderate slipstream deflection. Aircraft could take off vertically and it could hover.

• **Kaman K-16B,** under development for U. S. Navy, will be powered by two General Electric T58 turbines, canted at 30 deg. Controllable flaps on propel-

THIS HYDRAULIC FUSE MAY SAVE AN AIRCRAFT

It will permit:

Continued hydraulic system function after a sub-system failure.

And can provide:

A degree of fire protection by limiting the amount of fluid loss in the event of tube or component failure.

Quantity measuring fuses are generally installed in a sub-system directly adjacent to main system junction for maximum protection. The fuse, which totalizes the flow to the sub-system cylinder, is intended to close when a failure is indicated by a demand for an excessive quantity of fluid.

Quantity Measuring Fuses are available in two types, both fully qualified per MIL-F-5508A for — 65° to + 160° F., 3000 PSI systems (weight = 0.39 lbs.)

Type 1 . . .

AN6281 will reset automatically from partial closing when sub-system demand is satisfied—Requires no reverse flow.

Type 2 . . .

AN6282 will totalize flow increments and maintain fixed total capacity regardless of number of increments. Sub-total is erased by reverse flow.

Other fuses are available for — 65° F. to + 275° F. systems.

Write for Bulletin A-100

Waterman can also supply pressure compensated hydraulic flow regulators per MS 28886 in any line size.

Also suppliers of similar items and other Hydraulic Components for Industrial usage

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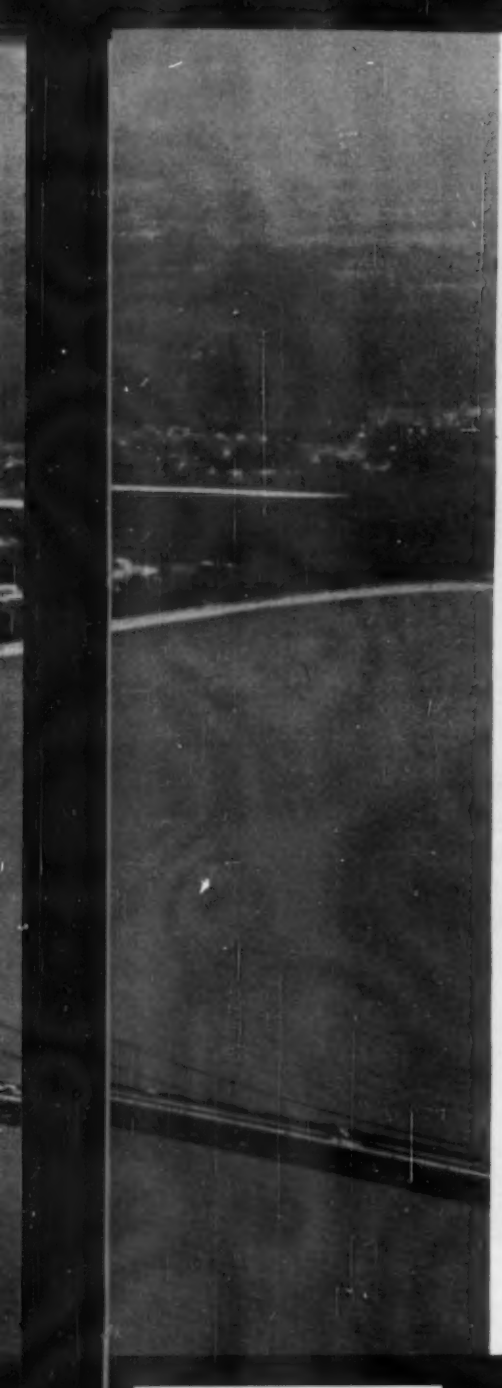
The four-ton H-16, first in Vertol's series of turbine-powered helicopters, flown in 1955.

The H-21D research aircraft equipped with two GE T-58 turbo-shaft engines, flown in 1957.

The Vertol 105 with two Lycoming T-53 engines used in the test programs, flown in 1957.



Why Vertol leads in turbine helicopter design and development

Steady progress in helicopter technology has advanced this versatile air vehicle to the threshold of a new era of usefulness. It is the era of the turbine-powered transport helicopter designed for improved battlefield mobility and logistical support of combat elements and missile systems, and for all-weather, day-night operations.

Vertol has been and is today at the forefront in progress toward this new achievement. Among the first to recognize that turbine power would vastly improve performance, capacity and versatility, Vertol also is a leader in research and development on new designs incorporating these powerplants.

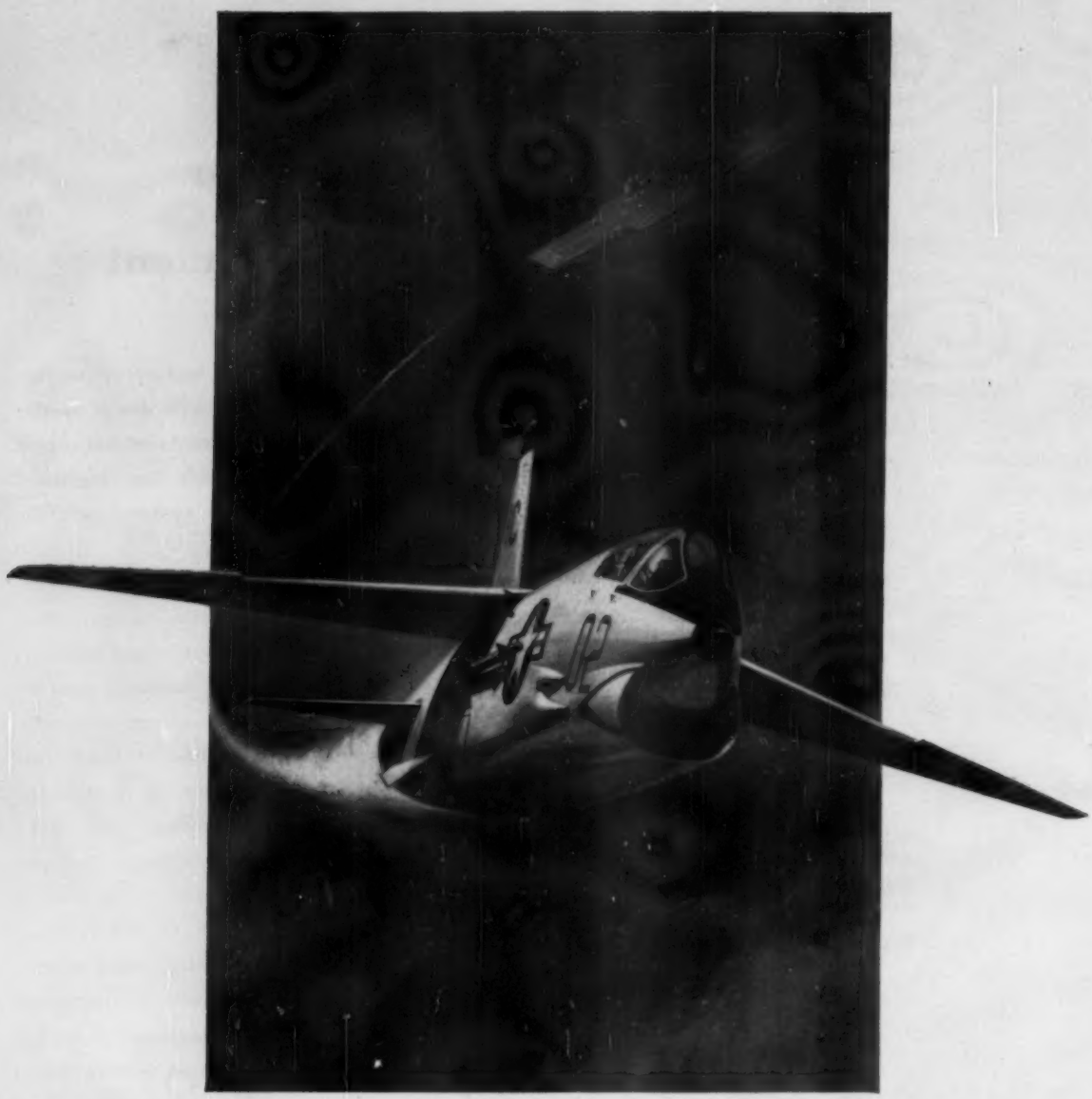
The result of many years of work in this field is the Vertol 107, first member of an entirely new generation of multi-turbine helicopters destined to play vital roles in short-range transportation throughout the world. It is now being produced for the U.S. Army as the YHC-1. The 107 can be adapted to an almost limitless variety of functions without altering basic design. Its growth potentialities are built in, assuring a steady progression of helicopters with even greater performance, load-carrying ability and versatility. Detailed engineering on growth versions of the 107, which will incorporate more advanced engines now in development, is under way.

In 1958 the Vertol 76, powered by the Lycoming T-53 was the world's first successful tilt-wing VTOL.

VERTOL Aircraft Corporation

MORTON, PENNSYLVANIA

SUBSIDIARY ALLIED RESEARCH ASSOCIATES, INC., BOSTON, MASS.



NEW VOUGHT CRUSADER FOR FLEET NEXT YEAR!

Navy orders fourth version of flexible, economical fighter

For the fourth time in three years, a new *Crusader* type is extending the power of the Fleet. Chance Vought's F8U-2N has been ordered by the Navy for delivery next year. It will deploy alongside the Navy's swiftest photoplanes and two first line day fighters – all *Crusaders.*

The F8U-2N is another step in *Crusader* growth. Speed of this newest version has been advanced to near Mach 2. It will carry the deadliest air-to-air missiles. It is instrumented and radar-equipped for supersonic combat in darkness or bad weather.

This will be a new capability for the Fleet. Yet it is being acquired at low risk and cost. The F8U-2N's basic design has been proved simple, serviceable and economical . . . compiling an enviable performance record in a year of foreign duty with two Fleets.

Again, the growth provisions of the Vought *Crusader* have provided immediate, low-cost upgrading of the Fleet's aircraft inventory.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

ler blades give the pilot control at slow speeds (hovering to 50 mph.). Above 50 mph. the flap control system automatically phases out and conventional airplane controls take over.

• **Vertol 76,** turbine-powered tilt-wing research aircraft developed under sponsorship of the U. S. Army and coordinated through the Office of Naval Research. Powerplant is a single Lycoming YT53-L-1. During conversion from hover to airplane flight, the lateral control system automatically changes to airplane controls, differential collective pitch system phases out and a conventional aileron system simultaneously reorients itself and phases in. Testbed will be evaluated by the National Aeronautical and Space Administration.

• **Hiller X-18** research vehicle, an airplane which has VTOL capabilities with its fuselage remaining in the horizontal plane. Gross weight is 33,000 lb. Allison T40-A-14 powerplants and 16 ft. 1 in. diameter Curtiss-Wright electric contra-rotating propellers were obtained from the Navy's Pogo (Lockheed) and (Convair) VTOL planes and logistics seaplane (Convair R3Y) programs. Funding of $5 million will carry the X-18 through 12 months of flight test. Wing tilt is accomplished by hydraulics; maximum airspeed at which wing can be tilted is 155 kt.

• **Bell XV-3,** experimental convertiplane, made its first conversion at 4,000 ft. and reached a speed of 115 kt. Power is supplied by a 450 hp. Pratt &Whitney R985 engine delivering 400 hp. to rotors. Normal gross weight is 4,700 lb.; empty weight about 3,500 lb. The wing is fixed; it is the rotor that tilts. Top helicopter speed is about 105 kt. Flaps have been added to the wings to reduce stalling speed in forward flight to about 85 kt.

• **Piesecki Model VZ-8P,** under design for Army, will be powered by two Lycoming flat piston engines. Speeds of 150 mph. are expected. Three-blade rotors are horizontally mounted in ducts fore and aft. Silhouette is low and flat. Fore and aft are inflated rubberized fabric bumpers. Three-wheel gear provides ground mobility.

• **Sikorsky delta-wing** convertiplane and compound helicopter, both currently under study. The convertiplane configuration embraces a single-blade rotor, which would stow at speeds approximating 100 kt. and the aircraft would become fixed-wing, with speed of about 500 kt. Compound helicopter would be a rotor-unloading type of aircraft with a fixed wing and propellers. It will not necessarily incorporate a tip-jet propulsion system.

• **Robertson VTOL,** vectored slipstream type aircraft, is aimed at the military market. Aircraft is four-place, with cruising range of about 1,000 mi. Power is supplied by two supercharged

THE NEW HILLER 12 E

(Undisputed performance leader for the toughest assignments of industry and commerce.)

THE HILLER OPERATOR

(Backbone of a fast growing service industry . . . he's invested in the best helicopter available.)

TOP TEAM IN PETROLEUM

(Survey and exploration – construction – personnel and equipment transport – inspection by executives and clients – supply – aerial ambulance – many others.)

*There is one important reason why any company in the petroleum industry should consider using helicopters... **to save time and money!** With the powerful new Hiller 12 E under the efficient direction of an experienced Hiller operator firm, the savings can become truly impressive. This 12 E standard of service is convenient, too; you can charter a 12 E by the trip or by the contract. For an illustrated brochure on the 12 E in action and information on Hiller Operators, write Dept. L, Commercial Division.*

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340-hp. Lycoming GSO-480 engines. The aircraft can be adapted to turboprop operation.

• **Bensen Model B-10,** expected to be developed and ready for production this summer, the prototype of which is a single-place, tandem twin-fan vehicle. Powerplants are vertically mounted 72-hp. McCulloch four-cylinder aircooled engines. First flight was last Aug. 6.

• **Fairchild VZ-5FA** testbed, being constructed as part of $1 million research and development contract awarded by Army's Transportation Research and Engineering Command. Vehicle is designed to prove feasibility of the vectored slipstream, the principles of which Fairchild has been researching for a number of years.

• **Ryan Vertiplane,** under joint Army-Navy sponsorship, completed wind tunnel testing at the Ames National Aeronautics and Space Administration Laboratory at Moffett Field, Calif. Vehicle crashed during flight tests last month (AW Feb. 23, p. 30), and a program delay is expected.

• **Gyrodyne XRON-1** rotocycle, developed under Navy contract, will soon be test flown by the military. Plans call for delivery of manned and remotely controlled rotocycles to the Navy by the end of the current year. Most significant development at Gyrodyne during the year was the automatic stabilization and remote control system and flight test in this configuration. Company expects certification of commercial version within the next two years.

• **Flying platforms,** the concept of which poses numerous stability and control problems. Vehicles currently under consideration by the Army include Chrysler's tandem-duct piston-powered platform, featuring rigid rotor-propellers and a system of vanes, louvers and cascades to provide propulsion, stability and control; Aerophysics VZ-7AP controllable pitch four rotor-propeller platform, powered by a 425-shp. Turbomeca Artouste 11B turbine, currently under construction, and the Piesecki VZ-8P tandem-duct platform previously referred to.

Army Testing

Active helicopter inventory of the U.S. Army numbers 2,193 rotocraft, with 2,467 planned for June 30, 1959, and 2,558 for June of 1960. Test activities being conducted by Army's Aviation Board embrace absolute altimeters, evaluation of the Bendix-Pacific Decca System, development of mirror system to aid in cargo hookup and release, evaluation of automatic stabilization equipment (Lear Sikorsky tests were completed last year; projected for test is the Sperry ASE).

Army also is conducting experiments

REC's NEW DEICED TEMPERATURE PROBE

This extraordinary new Model 102D gives accurate total temperature measurement *while* deicing heater operates

The unique ability of this probe to permit precise total temperature measurements *while* deicing heat is continuously applied opens up numerous possibilities. Model 102D will deice within one minute when subjected to icing conditions defined in Section 3.5, paragraph g of MIL-P-25632A (USAF). Model 102D is designed for use at flight speeds up to Mach 2 and higher.

Tell us about your project. We welcome your inquiry for complete information on Model 102D, or any of REC's many other precision units.

NEW CATALOG. No. 115811. Illustrated compilation of data on over 50 different REC probes ranging from −260° C. to 1500° C., plus REC pressure transducers and pitot-static tubes.

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Only the MARMAN CONOSEAL Joint

PROVIDES ALL THESE ADVANTAGES

100% Metal! That's Why MARMAN CONOSEAL Joints Assure Unlimited Shelf Life With Perfect Seal

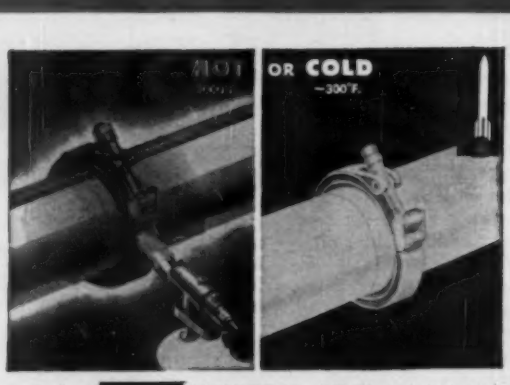
Marman's all-metal CONOSEAL Joint provides two basic advantages over organically sealed tube joints:

1—shelf life is practically unlimited
2—seal is maintained from —300°F. to 2000°F.

The CONOSEAL Joint utilizes a new concept of metal-to-metal sealing in which the conical metal gasket is completely encased by mating flanges. Compressed radially and axially, the gasket forms a superior seal that withstands extreme pressures and wide thermal cycling. Distortion, shock, even minor linear deflections are absorbed without loss of seal.

The compact design of the Marman CONOSEAL Joint eliminates envelope clearance needed. Single bolt fastening simplifies installation. Ideal for fluid transfer lines and structural parts, it is available in four weight/strength configurations for both air and ground installations. Mail coupon for complete new catalog.

CONOSEAL is an Aerojet trademark.



Only MARMAN CONOSEAL All-Metal Joint Gives You Perfect Seal

From real hot missile engine heat to the super cold of the laboratory —and at all temperatures in between—the versatile, all-metal Marman CONOSEAL Joint connects tubing and gives a perfect seal. Even linear deflections up to 1/16 inch, the result of temperature and pressure extremes on tubing of dissimilar metals, are accommodated without loss of perfect seal.

The Marman CONOSEAL Joint installs quickly because it fastens with a single bolt, requires minimum envelope clearance because of its compact design, assures indefinite shelf life because it is all metal. It is recommended for use with a wide range of fluids including liquid metals. Four configurations, from light to heavy duty, meet a wide range of requirements with maximum savings in weight.

Return the coupon for complete information.

CONOSEAL is an Aerojet trademark.

"CONOSEAL is an Aerojet trademark."

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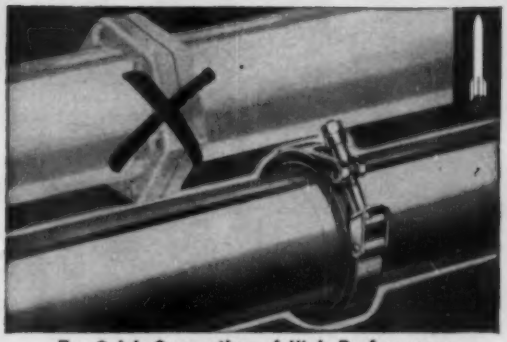


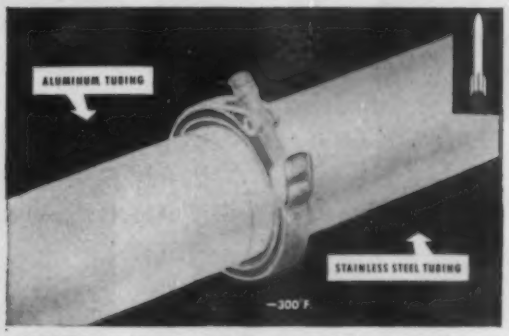
For Quick Connection of High Performance Tubing, Specify MARMAN CONOSEAL Joints

ONE BOLT FASTENS SECURELY

Connect high performance tubing quickly! Get perfect seal! Use the Marman CONOSEAL Joint that tightens with a single bolt—a simple, positive operation even in confined areas.

Important design advantages: The Marman CONOSEAL Joint requires minimum envelope clearance because its diameter is only slightly larger than the tubing it connects. Four configurations, light to heavy duty, provide maximum opportunities for weight savings.

Important operating advantages: The Marman CONOSEAL Joint seals perfectly at extreme temperatures. It joins tubing of dissimilar metals, and accommodates linear deflections up to 1/16 inch resulting from temperature and pressure variations. It has indefinite shelf life because it is all metal, and it may be used for many fluids, including liquid metals. Return the coupon for complete information.



MARMAN CONOSEAL Joints Assure Perfect Seal of Dissimilar Metals at Extreme Low Temperatures

Even at extreme cold of —300° F., tubing of dissimilar metals can be joined in a perfect seal by the all-metal CONOSEAL Joint. Seal is maintained through the full temperature range up to red hot 2000° F. (for applicable tubing). Strength and sealing capabilities are also unaffected by distortion, shock or minor linear deflections.

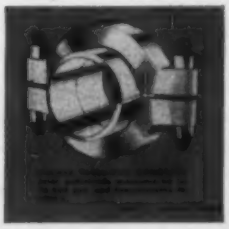
The Marman CONOSEAL Joint assures unlimited shelf life because it is made entirely of metals not subject to deterioration. Its compact design requires minimum envelope clearance; single bolt fastening simplifies installation. Recommended for a wide range of fluids, including liquid metals, the CONOSEAL Joint is available in four weight/strength configurations. Mail coupon below for complete new catalog.

MARMAN Heavy-Duty CONOSEAL JOINT Seals Perfectly at High Temperatures and Pressures

Where extremes of pressure and temperature are standard operating conditions for fluid lines, specify the all-metal Marman Heavy-Duty CONOSEAL Joint. It is designed to provide absolute dependability in connecting and sealing piping, even when subject to severe shock and distortion.

Marman Heavy-Duty CONOSEAL Joints provide maximum insurance against leakage or failure where dissimilar materials must be joined, such as stainless steel to aluminum or Zircaloy. Made entirely of metals not subject to deterioration, CONOSEAL Joints have long shelf life, require no maintenance.

Successfully performing now on jet and rocket engine test stands, high pressure fueling systems, missile test stands and launching platforms, the Heavy-Duty CONOSEAL Joint offers rugged dependability and simplicity of installation to meet a wide range of ground applications. Lightweight configurations of the CONOSEAL Joint are also available for aircraft and missile applications. Mail coupon below for full information.



Solve high performance tube and pipe joining problems with the versatile Marman all metal CONOSEAL Joint. Four configurations, covering temperature requirements from —300°F. to +2000°F. and pressure requirements from 1200 psig. to 6000 psig., are available for a wide range of missile, ground support equipment, aircraft and other applications. Weight-saving, space-saving Marman CONOSEAL Joints are leakproof, simplify tubing installation, accommodate linear deflections, assure indefinite shelf life. Return the coupon for complete information.

MARMAN DIVISION

Aeroquip Corporation

AP-2

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Title _____

Company _____

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City _____ Zone _____ State _____

new AMPEX FM Calibration Unit stands alone

Calibrating and aligning FM recording systems used to require hours of a specialist's time plus a considerable amount of test equipment. The Ampex TC-10 reduces both of these requirements drastically.

Even a non-technical person can calibrate a complete FM recording set-up quickly and accurately with no other test gear—and, with an oscilloscope, adjust the critical damping of an FM demodulator to optimize the rise-time vs overshoot characteristic.

As a high-accuracy voltage standard, the instrument provides 1.4142 volts, DC regulated by a three-stage circuit of pre-aged, temperature-compensated Zener diodes. Modified Kelvin-Varley circuitry eliminates loading effects on the voltage standard. Gold-plated chopper contacts and solid silver-alloy switch contacts throughout minimize thermo-electrical effects.

All-transistor circuits provide instant warmup and negligible power consumption. The nine oscillators are crystal-controlled for maximum precision. The complete Calibration Unit in its tough, handsome fiberglass case is light and small enough to be carried about easily.

TC-10 SPECIFICATIONS

Unit includes DC-voltage supply, AC-frequency source, square-wave modulator, and monitoring circuits for frequency and voltage adjustment.

Weight . . . . Approximately 25 pounds
Size . . . . . 8¾ x 16 x 16 inches overall
Panel is 8¾ x 15⅝ inches
Operating temperature . 30° to 110°F

	CALIBRATION accurate to	STABILITY accurate to
Frequency standard	1 part in 10^8	1 part in 10^9 per year
Reference voltage	0.01%	within 0.01%

For complete specifications call your Ampex data specialist — or write

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Offices serve U. S. A. and Canada

HILLER UH-12E

in arming of its helicopters, with the exception of the H-37, with machine guns, fin stabilized rockets and 20 mm. cannons. A helicopter instrument training program also is under way.

Cessna Aircraft, which is taking a shot at the helicopter market with its CH1-C, has run evaluation tests with the Army at Fort Rucker, Ala., aimed at pointing up the instrument-trainer capabilities of this helicopter.

Navy and Marine helicopter inventory during 1958 totaled 900 units. This compares with 800 units a year earlier and an estimated 1,000 for 1959. Air Force inventory last year totaled 330 units, as against 360 in 1957 and but 300 estimated for 1959.

Firefighting and forestry patrol missions together entailed about 2,500 hr. of helicopter time during 1958. Some 11,400 "helispots" have been created in California national forests, according to the Helicopter Assn. of America.

Last year the first official action to set U. S. heliport design and development criteria was taken as the Civil Aeronautics Administration (now the Federal Aviation Agency) appointed a nine-member industry-government committee to study the problem.

In relation to military orders, the Navy this year is purchasing a moderate quantity of Kaman HU2K-1 helicopters and a moderate quantity of Sikorsky HSS-2, HSS-1N and HUS-1 rotorcraft.

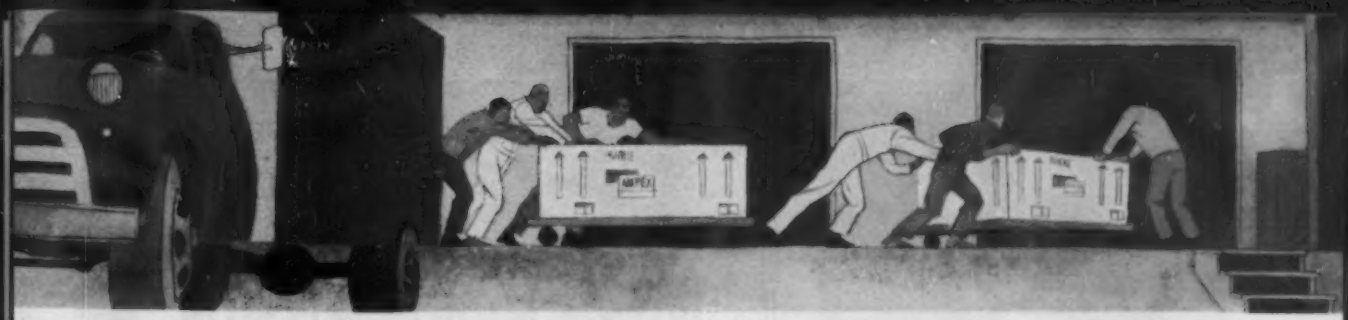
The Navy also is evaluating Gyrodyne drones: the DSN-1 and DSN-2. Air Force helicopter orders have been limited to the Kaman H-43A and H-43B. Eighteen of the former have been contracted for, in addition to the previously mentioned 74-unit contracts for the B model.

Emphasis on all-weather instrumentation has increased the role of the long range Army-Navy Instrument Program (ANIP). Commercially, Bell Helicopters during the year developed a full instrumented H-13 for use by the Airways Modernization Board's navigational helicopter study in the New York City area.

This instrumentation was a modification of the all-weather, blind flight equipment developed by Bell, Bendix and Decca and introduced in 1957.

While the commercial market has been somewhat blighted this year by the recession, the industry expects it to grow as part of the total market (AW, Sept. 1, 1958).

Rotorcraft improvements, plus increasing public acceptance and the additional uses found for the helicopter, are viewed as keys to this growth.



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. . . your AMPEX Field Service Engineer

Ampex service begins the moment your new equipment comes out of the cases. Whether it is a single FR-100A or a complete digital tape handling system, your Ampex Service Engineer is there on installation day.

He sees to the proper installation of your equipment. He tests it with its original factory checkout tape and specially designed calibration units. And he thoroughly instructs your staff in its operation.

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We invite qualified engineers and scientists to send a detailed resume at once so advanced arrangements can be made for a confidential interview. Write to Mr. G. N. McMillan, Engineering Personnel Administrator, Department 130-90.

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Business Plane Volume Bucks Recession

By Erwin J. Bulban

Business flying passed through the 1958 recession to set new records for deliveries, dollar volumes and utilization of its products by its customers, underlining its importance to the nation's industrial complex and providing further proof of the solidity it provides as a growing market for suppliers to the aviation industry.

As in 1954, when the prophets forecast, that with the lifting of corporation excess profits taxes many a company-operated aircraft would find its way onto the used airplane lot, the builders and users of U.S. business and utility aircraft last year also confounded the recession pessimists.

These significant marks were set:

• **Number of units** delivered increased 300 over 1957 to total 6,416, including a twin-jet Beech MS 760 and two turboprop-powered Fairchild F.27s.

• **Dollar volume,** figured at the builders' net billing prices—before markup by distributors and dealers—totaled more than $101.5 million. This represented a healthy $135 million-plus at retail compared with $99.6 million in billings and a retail value of $125 million the previous year, and a four times increase over only five years ago.

• **Flying hours** by business plane operators increased to an estimated 5.3 million compared to 4.9 million hours in 1957 and represented approximately 1.5 million hours more than were flown by the nation's scheduled domestic airlines last year. The steady climb of business plane flying hours—which have increased 150% in the past decade, National Business Aircraft Assn. estimates—is tending to a radical increase in rate of growth, which will be reflected in business plane hours pulling away sharply over airline hours in the next decade, industry observers believe.

Business flyers currently are logging 50% of all the time spent in the air by all segments of general aviation, which represents all flying other than that done by the military and scheduled airlines. In 1957, business pilots totaled approximately 47% of the time spent aloft by all segments of general aviation.

Pointing up the optimistic feelings of an industry, which has become overly conservative in forecasting the future since the bleak days following collapse of GI-training in 1947, a tabulation made by its members for Federal Aviation Agency Administrator E. R. Quesada recently indicated that it expects to sell $1 billion worth of new business and utility aircraft in the five years 1958-1962.

In this period it will spent $80-$100 million on research and development, new facilities and equipment. Volume of fixed base operations related to sales and maintenance of business and utility planes—new operating at a rate of approximately $500,000,000 annually—can well double and gross capital investment in service facilities—now estimated at $200 million—can triple in this time.

Dollar volumes will be boosted measurably as deliveries increase of the new turbine-powered executive transports, such as the Fairchild F-27, of which

PIPER COMANCHES

approximately 20 are scheduled for corporations. This year will mark first deliveries of Grumman's Gulfstream, on which the company has a backlog of approximately 40. Although sales of these larger airplanes represent relatively few units in the over-all business flying total, their five-figure basic prices will significantly increase the totals for 1959 and onwards.

Fairchild, with 20 firm corporate orders on its books for F-27 turboprop-powered transports, had delivered eight executive airplanes as of late February, and reports that its early customers already had logged considerable time on their airplanes as of that date.

Jet-powered business aircraft picture has improved greatly in a year's time, with a wide variety of hardware flying, from the small twin-jet Beech MS 760—the only one that can be delivered now—to the twin-jet North American Sabreliner, the Lockheed two-or-four-engine Jetstar and the McDonnell Model 119 four-jet.

Two MS 760s have been purchased by U.S. private buyers from Beech, which is distributing the $210,000 airplane through arrangements with its French builder. North American has garnered an initial contract from USAF for the T-39 trainer version of the Sabreliner but has made no public pronouncements on the airplane's civil future. The company is known to be conducting market surveys in this field covering both the western hemisphere and abroad.

McDonnell 119, which is in direct competition with the Jetstar for the USAF UCX four-engine utility transport class, has indicated its commercial interest by setting up a Transport Division responsible to top company management.

First break in the larger jet-powered executive class apparently has been made by Lockheed's Marietta (Ga.) Division, which is scheduling a firm delivery to a private customer in January 1961. Marietta now has both Jetstar prototypes, which have accumulated a total of 750 flight hours and are now undergoing detailed engineering tests and preliminary FAA certification trials. Company is tooling up for Jetstar production, with plans calling for lines building civil and military models simultaneously.

Currently the division has approximately 70 production line positions reserved for civil Jetstars and its sales department is now firming up these contracts and working out specifications with these potential customers, including equipment and interior details.

Initial production Jetstar for the number one customer will have four Pratt & Whitney JT12s. Company expects to get delivery on prototype JT12s for installation in one of the two airplanes now under flight test late this year or early next year. It expects to get FAA-certificated JT12s in October, 1960.

The 2,500-lb.-thrust-class JT12 has quickly scored major success in the new light jet transport field and is now specified for the Sabreliner, McDonnell 119 and Jetstar. Engine was publicly intro-

U.S. Business & Utility Aircraft Shipments—1958

(Number of Units, Builders' Net Billing-thousands of dollars)

Make & Model	January	February	March	April	May	June	July	August	September	October	November	December	Totals
Aero Design 500	0	0	0	0	0	0	2	9	4	4	7	5	31
560E	1	2	2	3	3	1	2	2	0	0	1	1	18
680, 680E	2	0	5	5	6	5	5	5	2	4	4	2	46
720	0	0	0	0	0	0	0	0	1	1	0	0	2
	$227	$128	$486	$636	$680	$567	$883	$997	$509	$696	$788	$515	$6,902
Beech E18S	4	6	5	5	6	5	6	5	5	3	5	4	60
MS 760	0	0	0	0	0	0	0	0	1	0	0	0	1
Bonanza	39	36	40	40	34	29	29	20	16	29	29	35	376
Twin-Bonanza	5	7	9	6	6	4	1	5	4	4	5	3	60
Mentor [1]	0	0	0	16	0	10	0	0	0	0	0	0	26
Travel Air	29	29	24	22	21	16	7	5	6	6	9	7	172
	$2,581	$2,602	$3,154	$3,112	$2,693	$2,291	$1,570	$1,640	$1,673	$1,438	$1,978	$1,730	$26,660
Call Air A4	0	2	4	5	6	4	5	0	0	0	0	0	26
A5	0	0	0	0	0	0	0	0	3	2	1	1	13
A6	0	0	0	0	0	0	0	1	1	1	0	1	4
	$0	$17	$23	$34	$38	$28	$44	$31	$29	$21	$8	$15	$296
Cessna 150	0	0	0	0	0	0	0	0	0	17	37	68	122
172	65	77	55	72	57	48	41	16	4	214	84	57	790
175	0	0	146	126	87	85	73	60	60	37	19	9	702
180	24	26	23	26	27	21	16	10	12	7	29	41	262
182, Skylane	132	80	63	90	73	70	70	48	47	32	26	143	674
310B	21	25	23	16	12	11	11	13	10	7	1	25	176
	$3,605	$3,223	$4,044	$3,993	$3,036	$2,885	$2,595	$2,076	$1,809	$3,022	$1,834	$4,775	$36,897
Champion 7EC	2	2	6	8	7	3	7	1	8	2	3	1	50
7FC	23	21	19	16	22	23	16	11	9	16	7	17	200
7GC	0	0	0	0	0	0	0	10	9	7	12	8	46
	$128	$113	$127	$123	$146	$131	$116	$114	$134	$128	$118	$138	$1,516
Colonial Skimmer	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	6
	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	$138
Fairchild F-27	0	0	0	0	0	0	0	0	0	0	1	1	2
	0	0	0	0	0	0	0	0	0	0	....	....	$1,500[2]
Helio H-391B Courier	4	4	1	3	1	2	0	1	1	2	1	1	21
	$112	$114	$27	$89	$24	$59	$0	$33	$33	$67	$26	$29	$613
Mooney Mk. 20	10	6	13	13	13	12	12	9	16	13[1]	34	9	160
	$106	$86	$167	$140	$147	$137	$137	$103	$182	$147	$433	$103	$1,860
Piper PA-18	10	22	13	21	24	13	13	19	14	7	13	13	182
PA-18-A	26	24	41	42	38	45	35	38	14	8	17	14	342
PA-22 Tri-Pacer	92	62	88	57	60	58	38	62	37	76	54	38	720
PA-23 Apache	25	24	40	39	29	29	21	21	15	15	27	19	304
PA-24 Comanche	26	16	34	24	47	62	43	61	76	75	81	67	614
	$1,979	$1,637	$2,573	$2,261	$2,348	$2,536	$1,640	$2,347	$2,103	$2,268	$2,611	$2,064	$26,548
Taylorcraft 20	1	1	1	1	1	1	1	1	1	N.R.	N.R.	N.R.	9
	$11	$11	$11	$11	$11	$11	$11	$11	$11	N.R.	N.R.	N.R.	$99
Totals (Aircraft)	341	463	556	555	580	550	454	440	378	589	507	599	6,416
Totals (Net Billing Prices)	$8,749	$8,111	$10,592	$10,399	$9,133	$8,645	$8,986	$7,352	$6,483	$7,785	$7,794	$9,350	$103,027

[1] Military primary trainer export sales, considered commercial transactions.
[2] Estimate.
[3] F-27 totals represent direct factory sales at retail.
N.A.—Not available. N.R.—Not reported.

CESSNA 310C

duced to business pilots for the first time at the National Business Aircraft Assn. annual forum last September (AW Sept. 29, p. 21).

Composition of the active business fleet, compiled by the association as of Jan. 1, 1958, shows that there were then 28,483 aircraft being operated primarily for this purpose. Of these 1,093 were multi-engine types seating nine or more; 2,749 were multi-engine seating fewer than nine persons; 15,234 were single-engine types seating three or more; 9,236 were single-engine with one or two seats and there were 171 miscellaneous types including helicopters, surplus jets and the like.

Equipment Statistics

For equipment, NBAA estimates that 16,000 of the 28,000 aircraft used primarily for business flying are fully equipped for instrument (IFR) flight; 13,464 have VOR omni-range equipment; 26,000 have a radio receiver; 25,000 have a transmitter; 12,500 have manual direction finder; 7,500 have automatic direction finder (ADF); 2,500 have autopilot; 6,000 are equipped with instrument landing system (ILS) localizer and 1,500 have an ILS glide slope.

In addition to this base of 28,483 planes, NBAA estimates that another 10,000 were being used partially for some form of business activity.

The turboprops and jets are the glamor ships of the industry; the large multi-engine piston types also look impressive on the tally sheet. But by and large the big gains made in business flying are in the utility of the small four-place single-engine and five-place twin-engine types, which very often equal their more powerful bigger brothers in performance block-to-block at an economy the larger airplanes cannot match.

Two major problems facing the op-

AERO DESIGN ALTI-CRUISER

BEECH TRAVEL-AIR

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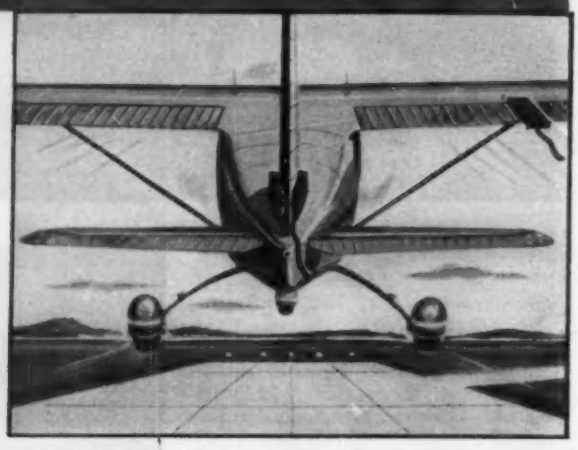
WING TIPS

COMPASS CAPERS. Metal objects such as pliers, earphones (particularly when on the head), cameras, etc., when positioned near your compass, can cause a deviation of many degrees. Also, prop de-icers, when turned on, can make it read up to 12° off.



POINT OF NO RETURN. Even experienced pilots have sometimes taken off with gust locks still firmly attached to ailerons, elevators and rudder. Avoid foolish mistakes like this. Always check your controls for full freedom of movement before taking off.

BLIND TAKE-OFF. Be careful of puddles on the runway. Water splashing onto the windshield can obscure vision completely. And in freezing weather the resulting ice may be difficult to remove.

REMEMBER! For "Happy Flying"... look for the famous ESSO Sign for the most dependable aviation products.

FLYING CHARGE ACCOUNT. Here's real convenience – get an Esso Aviation Credit Card from your Esso Aviation Dealer. When you land, your plane can be completely serviced without making any cash payment. With an Esso Credit Card, you can charge gasoline, oil, and lubricants *plus* tire and battery service, landing fees, overnight in-transit storage and minor repairs.

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erators of these 28,000-plus business aircraft—greatly outnumbering the approximately 1,750-plane airline fleet—are the inadequate traffic control system and need for an airport expansion program that will not only permit the current aircraft to operate more efficiently into more areas, but also hold back many firms from getting into use of business airplanes.

In congested areas, flying using visual flight rules is increasingly difficult under current procedures of mixing VFR and instrument traffic along the airways and at terminal points. Putting all of the airplanes capable of IFR on instrument rules, under the now-inadequate system, would choke facilities to the point where very little traffic would move and airline operations could be brought practically to a stand-still.

Data Problems

Yet in attempting to develop the requirements for all aviation, civil and military, Federal Aviation Agency lacks sufficient up-to-date data on the largest segment of flying, general aviation. Many of its statistics are at least two years old and the accuracy of these is questionable because of the relatively small samplings they embrace. Thus many segments of general aviation question FAA's ability to predict its requirements and the reliability of any planning the agency may do. The federal government now can provide more accurate and detailed data on the country's livestock population than it can on its rapidly expanding air fleet.

Recognizing the problem of providing a unified and cohesive organization representing general aviation, 11 major organizations have formed the General Aviation Council to maintain machinery for coordinating common problems and making possible more direct contact with top level FAA and other government officials.

In the 1954-1958 period the business and utility aircraft industry delivered more than 4,000 multi-engine types, most of them in the four-five seat category. Army and Air Force have made significantly large purchases of these models too—USAF experience with the economy and performance of initial batch of 80 Cessna 310s prompted an additional award for a further 80 airplanes, redesignated U-3A (AW Sept. 29, 1958, p. 81). Operating costs of only $15.98 per flying hour, simplified maintenance and higher performance compared to other obsolete or obsolescent equipment used for the light utility mission spurred USAF to place its contracts. Increased production volume resulting from USAF orders allowed Cessna to market the improved 310C civilian counterpart at no increase in price over the previous model.

Competition in this field finds the manufacturers working steadily to improve their current models and plan new airplanes to fill the gap in their line that may lead their present customer to trade his airplane for another make when he feels he needs additional performance to stay competitive. Aero Design last year expanded its Commander line to bring out an economy version, the Model 500, in an effort to cut into the 310 market; Piper in 1959 will start production of the Aztec, a high-performance light twin based on its Apache experience; Beech now has flying a considerably modified version of its Twin-Bonanza with an enlarged fuselage which features a passenger door in the side which should answer

U. S. Business & Utility Aircraft Exports

Country	Units 1958	Units 1957	$ Value (000s) 1958	$ Value (000s) 1957
Foreign				
Afghanistan	N.R.	1	N.R.	5
Algeria	N.R.	6	N.R.	286
Argentina	34	198	637.2	2,667
Australia	62	46	657.3	533
Austria	7	15	58.7	69
Belgian Congo	N.R.	1	N.R.	5
Belgium	6	8	261.6	396
Bolivia	4	4	117	84
Brazil	59	63	950.8	1,712
British E. Africa	2	6	21.8	67
British Guiana	1	1	7.2	6
British W. Africa	N.R.	1	N.R.	11
British W. Indies	2	N.R.	21.2	N.R.
Burma	N.R.	6	N.R.	528
Canada	168	156	2,102.2	2,150
Ceylon	2	N.R.	231.1	N.R.
Chile	6	14	74.6	275
Colombia	15	10	151.1	512
Costa Rica	7	8	76.5	79
Cuba	14	8	141.1	68
Denmark	1	N.R.	9.4	N.R.
Dominican Republic	6	N.R.	36.8	N.R.
Ecuador	6	2	35.8	16
El Salvador	5	4	46.1	46
England	3	1	42.6	30
France	5	9	78.3	320
French Equat. Africa	7	7	53.4	62
French E. Africa	4	N.R.	25.4	N.R.
French W. Africa	8	9	70.7	64
French W. Indies	1	N.R.	6.3	N.R.
French Morocco	7	N.R.	98.5	N.R.
Formosa	1	N.R.	27.3	N.R.
French Cameroons	2	N.R.	56.9	N.R.
Germany	21	19	290.2	458
Guatemala	19	7	187.9	93
Honduras	6	9	61.9	86
Iceland	1	N.R.	6.0	N.R.
India	N.R.	1	N.R.	6
Indonesia	N.R.	2	N.R.	12
Iran	3	7	24.3	43
Iraq	N.R.	5	N.R.	34
Ireland	5	3	78.9	46
Israel	5	5	30.2	29
Jamaica	N.R.	1	N.R.	5
Japan	7	7	174.2	274
Jordan	1	N.R.	83.7	N.R.
Laos	N.R.	2	N.R.	13
Liberia	2	2	34.4	10
Libya	N.R.	1	N.R.	6
Madagascar	2	2	19.6	11
Mexico	47	81	936.9	1,022
Morocco	3	5	29.4	409
Malaya	1	N.R.	67.5	N.R.
Netherlands	1	3	27.4	33
New Caledonia	N.R.	1	N.R.	6
New Zealand	12	78	78.7	546
Nicaragua	18	17	144	106
Norway	8	5	62.2	50
New Guinea	1	N.R.	11.2	N.R.
Nigeria	3	N.R.	35.1	N.R.
Pakistan	3	1	76.6	6
Panama	1	2	10.6	18
Paraguay	25	6	300.8	80
Peru	N.R.	6	N.R.	62
Philippine Rep.	5	2	97.1	22
Portugal	4	2	25.6	11
Portuguese E. Africa	N.R.	1	N.R.	11
Rhodesia	1	N.R.	51.2	N.R.
Saudi Arabia	1	N.R.	8.4	N.R.
Spain	1	N.R.	13.7	N.R.
Sweden	16	7	123.2	38
Switzerland	18	25	396.2	428
Singapore	2	N.R.	17.8	N.R.
Southwest Africa	1	N.R.	12.6	N.R.
Trinidad	N.R.	1	N.R.	27
Union of So. Africa	71	58	995	735
Uruguay	5	94	35.5	1,061
Venezuela	13	15	438.1	613
Totals	**778**	**1,047**	**11,082.5**	**16,401**
U. S. Territorial				
Alaska	81	75	746.5	642
Puerto Rico	5	9	206.4	330
Hawaii	1	N.R.	9.4	N.R.
Totals	**87**	**84**	**962.3**	**972**
Complete Totals	**865**	**1,131**	**12,044.8**	**17,373**

N.R.—No exports reported.

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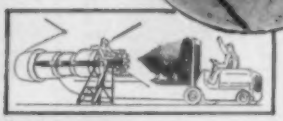
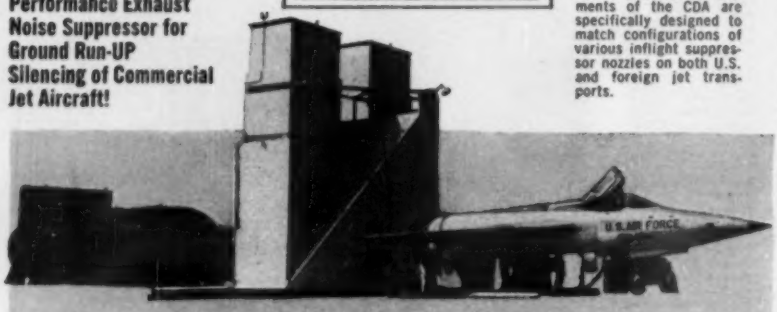


Photograph of CDA Silencer attached to jet engine of a Boeing "707" airliner shows how the acoustical elements of the CDA are specifically designed to match configurations of various inflight suppressor nozzles on both U.S. and foreign jet transports.

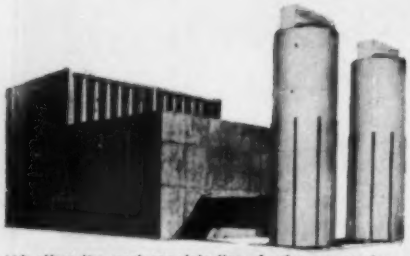


for military aircraft

At Republic Aviation, IAC's new "two story" ground muffler features a tail enclosure for complete and effective silencing of J-75 jet engines in F-105 aircraft. This new ground-run-up muffler which has been designed for full-power ground tests is demountable for relocation if desired.

for military and commercial aircraft

The trailer mounted MDU Ground Run-Up Silencer, adaptable to any aircraft or engine field operation offers a highly maneuverable unit for both military afterburner and commercial equipment. The MDU suppressor is adjustable to all engine positions.



for jet and rocket engines

IAC's proven DURA-STACK All-Steel Silencing Systems are effectively controlling noise of jet and rocket engines in test cells at both military and commercial installations around the world!

IAC offers the most complete line of noise suppression equipment engineered for jet and missile engines of today and tomorrow! Complete literature will be sent upon request.

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those critics who objected to climbing up over the wing and squeezing past the front seats to reach the rear seats. Perhaps significantly, this airplane is believed to be stressed to take additional growth including pressurized cabin and installation of turboprop engines when suitable powerplants are available in production quantities to civilians.

Business Plane Leader

Of the Big Four: Aero Design, Beech, Cessna and Piper, Cessna took the lead again last year in number of units delivered and dollar volume as the result of an aggressive sales campaign, backed by the largest selection of models in the industry. Its deliveries for calendar 1958 marked an increase of 527 units over the previous year, a gain of 22%, and estimated retail value totaled $48.8 million. Company estimates that it did 49.98% of the business plane sales of the top four manufacturers to achieve the biggest year of commercial aircraft dollar volume in its history.

Intensive sales efforts at factory and distributor-dealer levels, backed by a stringent cost reduction program to hold the price line—average price increases per airplane were $234, the company notes—contributed to the big sales volume last year. A major factor was its seven-model line, which provided sales force with a wider market potential than ever before possible. Its new two-place Model 150, which was introduced last year, tallied 122 deliveries. Initially aimed at serving the growing instructional flying and utility markets, considerable interest also has been shown by traveling salesmen and professional people. Interest also was shown by small and medium-size companies looking for an economical "second airplane."

In a few weeks Cessna will introduce an eighth business plane to its line—the high-performance high-wing single-engine Model 210 aimed at competing with Piper's low-wing retractable gear Comanche four-placer.

Further diversification during the year was acquisition of Aircraft Radio Corp., Boonton, N. J., marking Cessna's entry into the electronics manufacturing field.

Aircraft Radio is a long-time military supplier who has been making an extremely strong bid to build its commercial business.

Sales Rank

Comparing Beech, Cessna and Piper on a fiscal year basis—all three use the same 12-month period ending Sept. 30—Beech ranked first in total sales, aggregating $95.8 million, with commercial business accounting for $32.1 million and military totaling $63.7 mil-

lion, with net earnings after taxes coming to $3,324,663. Company's diversified aviation business, including business and military plane, subcontracts covering production of T-33A wings, F-104 aft fuselage, F-101 assemblies, F-105 aft fuselage, F-106 components and subassemblies of B-58 and 880 Jetliner, also target drones, encompass 60 different projects, provided the firm with a total military and civil backlog of $90 million-plus at the start of calendar 1959. Forecast of company sales for Fiscal 1959 is for $84 million.

Piper turned in total sales of $27,108,550 for its 1958 fiscal year, highest in the company's history, is shooting for a 30% gain in its current fiscal year. High production rate of its line is expected this year, principally for the Comanche. Two new models are slated for initial production this year; in addition to the 200-mph.-plus Aztec light twin, a new low-wing agricultural airplane—the Pawnee—will come out of Lock Haven, designed to provide a low-cost replacement for the PA-18-A. Also in the works is a two-place side-by-side personal and training airplane, the low-wing Papoose, now tagged in the $4,000-$5,000 price bracket. The fixed tricycle gear airplane will be powered by a 90-100-hp. engine. Project currently is undergoing preliminary design study and market evaluation, with considerable attention being given to developing new production techniques to hold the price down. Company feels that the Papoose is still several years away from its production lines.

Light Turboprops

Turboprop or jet-powered light business planes remain drawing board projects so far as the majority of long-time business plane manufacturers are concerned and there is no tangible evidence that any of these will be providing competition for their piston-powered brothers for several years. The major effort now is build up a diversified line of models and the trend in powerplants continues to be further improvement in the inline piston engine, with the power curve continuing upward. Last year saw a definite swing towards fuel-injection engines, which are finding favor due to anti-icing characteristics. With biggest sales in powerplants in the 180-hp., 250-hp. and 340-hp. classes, compared to 135-hp., 150-hp., 260-hp., several years ago, the immediate future for the majority of business planes seems geared to further developments of the inline piston. New models of these, some now running on the test stands, indicate that the in-line will cover the power spectrum up to 500-600 hp. in the next few years and the small turboprops perhaps taking hold in the mid-1960s.

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Foreign

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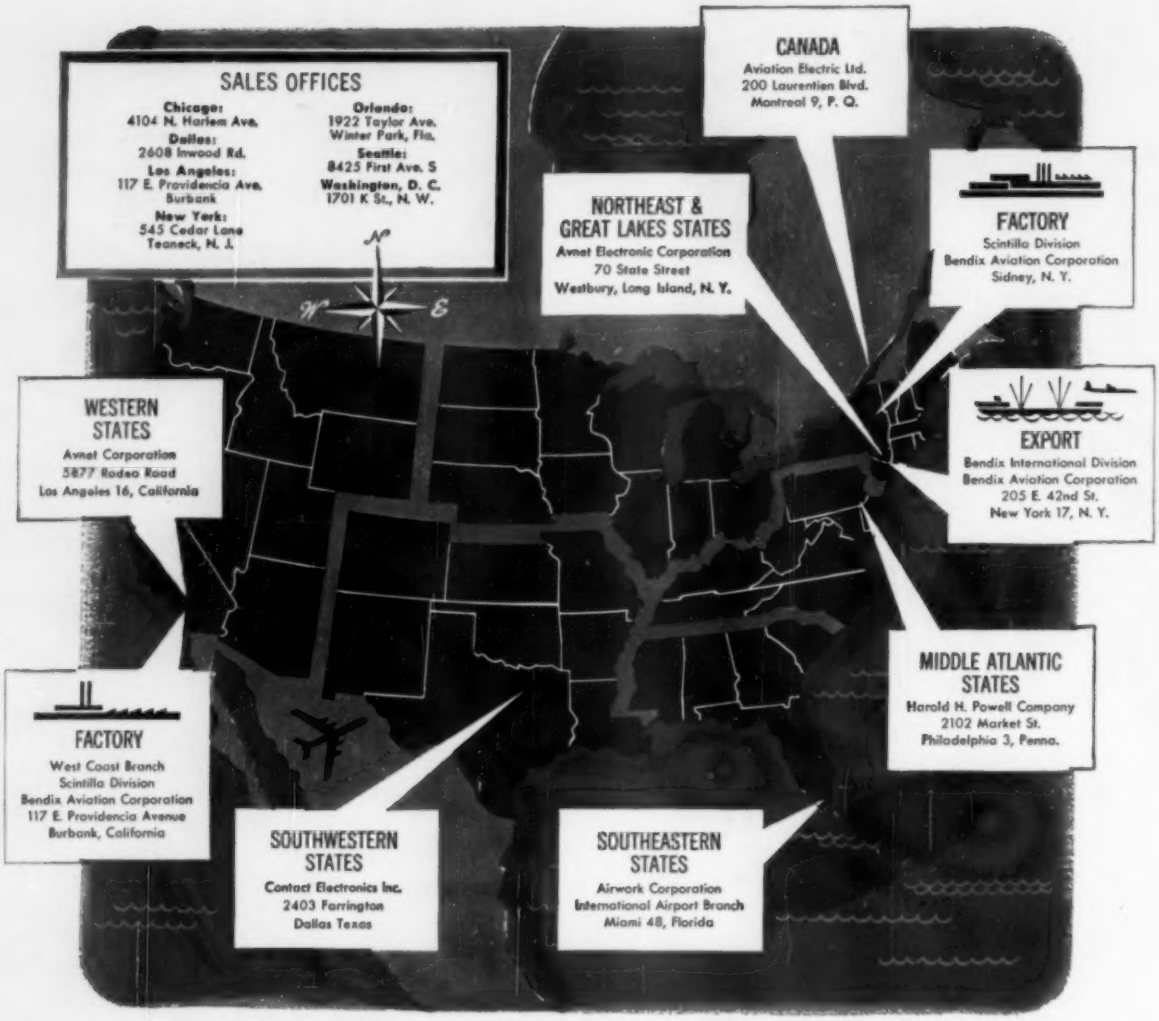

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VICKERS VANGUARD TURBOPROP TRANSPORT

Britain Tailors Industry to New Era

By John Tunstall

London—Vital new contract for the TSR. II supersonic tactical strike reconnaissance aircraft, imminent orders for a tactical and a strategic freighter, and for second generation helicopters were among a series of fast moving events which helped clarify and improve the confused aeronautical picture in Britain early this year.

The new requirements forced further regrouping of the industry which experts predict must be reduced ultimately to four airframe and two engine groups based on a strength of 150,000 workers.

There was the certainty of a bigger research and development budget and a strong possibility that a decision to proceed with a Mach 3 bomber or airliner would be made this spring.

During the year, two second generation turboprop airliners made maiden flights—Argosy and Vanguard. The Comet IV made its debut and the Fairey Rotodyne achieved a record cruise speed of 190 mph.

Two gas turbines reached overhaul lives of 2,000 hr. A larger one—the Tyne—with the same life potential started off with a fuel consumption of only 0.4 lb./bhp./hr. also claimed as unequalled.

A blind landing system invented by two government research establishments and developed by industry and the Decca hyperbolic short range navigational aid were demonstrated and have been adopted by British airlines. Both systems are fundamentally different from their American counterparts and are claimed by the British to be superior in all significant aspects of performance, weight and cost.

New research facilities opened include a Mach 4 (27 x 30 in.) wind tunnel at Bedford owned by the industry, and a $16 million engine test facility at Rolls Royce—the largest in Europe. Because of its ingenious layout it saved over three times its cost.

And Britain's first, modest probe into space with the Black Knight reentry test vehicle was acclaimed as the best spent $14 million at any firing range.

It happened also to be the best export year. Total exports equalled $420 million with engine exports making up one third.

Nevertheless, it proved a bitterly dis-

BLACKBURN NA.39

appointing one for the industry. No more than fifty new orders for its jet and turboprop airliners were received in spite of extensive world demonstration tours. Its military orders dried up, too, but this was anticipated.

Having pioneered the world market in gas turbine transport, developed engines, gathered airframe and operational knowhow, and having demonstrated their safety by extreme structural testing methods, why, Britain asks, don't the orders come in?

Sales Race Tightens

Among the reasons, say the manufacturers, is tougher competition—the British six year monopoly which earned $375 million in export dollars has now ended. World airlines, with big jet commitments, can't afford to re-equip their short and medium range aircraft fleets with turboprops. Sales have been lost also because of inadequate credit terms. The government-sponsored seven-year credit scheme announced in November will still help. But it came very late.

Overwhelming opinion in Britain believes that the solution of its own sales problem and that facing airlines is the introduction of a fare differential, and without a jet surcharge. Charging what the traffic can bear has been a "respected principle" in transport for a long time, Harold Watkinson, Britain's minister of civil aviation, has asserted.

Using turbine aircraft, existing fares could be slashed from 25 to 50%, the British believe, and the introduction of a differential fare structure will be strongly urged by the British on IATA members.

On the military side, after a frustrating delay—both unnecessary and harmful according to several important authorities—the government announced development contracts and orders for projects foreshadowed in the fateful White Paper of 1957. In January the newly formed Vickers-English Electric group received the supersonic TSR. II tactical bomber contract. Hawker-Siddeley gained an order for 20-30 Armstrong Whitworth Argosy tactical freighters and Short Bros. got the strategic freighter order. An earlier announcement had assured the industry that if a decision in favor of the strategic freighter were made it would be for British aircraft.

A substantial army order for second generation helicopters is also expected very soon to confirm another requirement foreshadowed in the 1957 White Paper. Under consideration in January for the award were the Fairey Rotodyne, Westland Westminster and the Bristol 192.

Besides these latest government prospects, English Electric received a substantial order for the trainer version of the P.1B Lightning, which is believed to bring the total of Lightnings ordered to about 200.

The research picture brightened too as it became apparent that the government's full support of basic research and development was to continue.

Cuts in the VTOL program, according to Shorts, had virtually been restored. The climate in boundary layer research has rapidly improved in recent weeks and new development contracts are expected, which might expedite development of a laminar flow airliner.

Supersonic Airliner

A decision to proceed with a supersonic airliner project is expected this month when the Supersonic Transport Aircraft Committee reports. This committee was set up three years ago by the Ministry of Supply and worked in conjunction with the Royal Aircraft Establishment and seven aircraft manufacturers. It had to decide whether the project was economically feasible and whether the configuration should aspire to the optimum economic cruising speed with turbojets of Mach 2.5-3—involving a switch to a steel or titanium airframe—or whether the design should stay with light alloys and accept a cruise limitation of around Mach 1.8.

Some observers believe that the committee, though heavily divided, favors going the whole way with a Mach 2.5-3 canard, slim-delta configuration of the type proposed by Handley Page. A small scale prototype on which to evaluate the configuration is believed to be

at an advanced stage. A steel research aircraft possibly at this stage of development is the Bristol 118. Development contract might be placed within the next 12 months and cost estimates of the whole project have reached as high as $250 million.

The Ministry has also announced its intention to support the development of the large supersonic Vickers Swallow variable geometry bomber project, now the subject of joint Anglo-American negotiations. Vickers has already begun recruiting systems, structure and kinetic heating technologists for the Swallow, which is one of the configurations studied by the supersonic airliner committee. The Vickers English-Electric partnership generates a virtual monopoly of supersonic know-how in Britain and makes it a formidable competitor in any subsequent supersonic contract.

Among other research develop contracts, AVIATION WEEK learns, is one involving a jet flap application awarded last year to Hunting Aircraft Ltd. This could be extremely significant in view of the short takeoff features, reportedly specified for the TSR. II.

VTOL Applications

Applications of the Short SC. 1 VTOL project are related to a type of supersonic airliner sponsored by Rolls-Royce. It was once slated for an early version of the TSR. II, may even still be used on a later version. Military applications include a flying crane for conveying vehicles over impassable terrain and for river crossings.

Actual geometry of the vertical engine cluster used in the SC. 1 VTOL has not been disclosed but the fact that the aircraft can hover in a crosswind without counteracting with control reaction might suggest that the engines generate a jet "tripod."

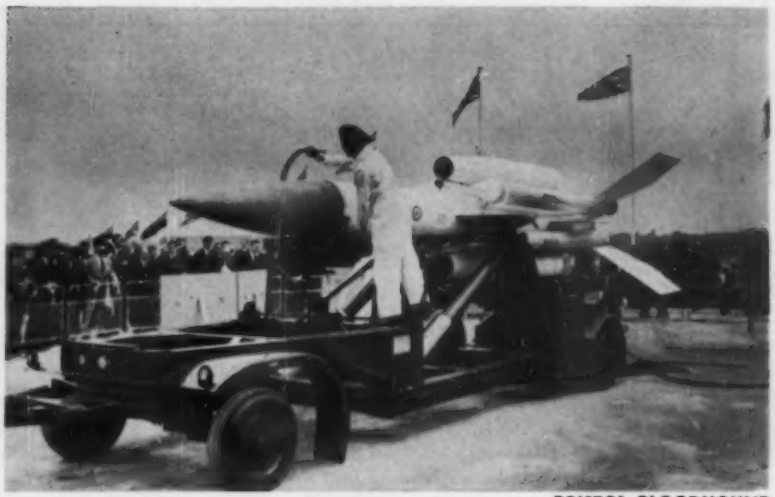
The aircraft has one thrust engine, four lift engines (vertical) which have most likely some slight pivoting movement to develop a horizontal component to assist transition.

Up to date, translation of the aircraft has been achieved through the control jets.

Larger Manufacturing Units

Reorganization of the industry into larger groups continues but the industry has a long way to go before attaining a strcture based on four major airframe and two major engine manufacturers, which is believed to have been among the recommendations made to the Government by the Padmore advisory committee.

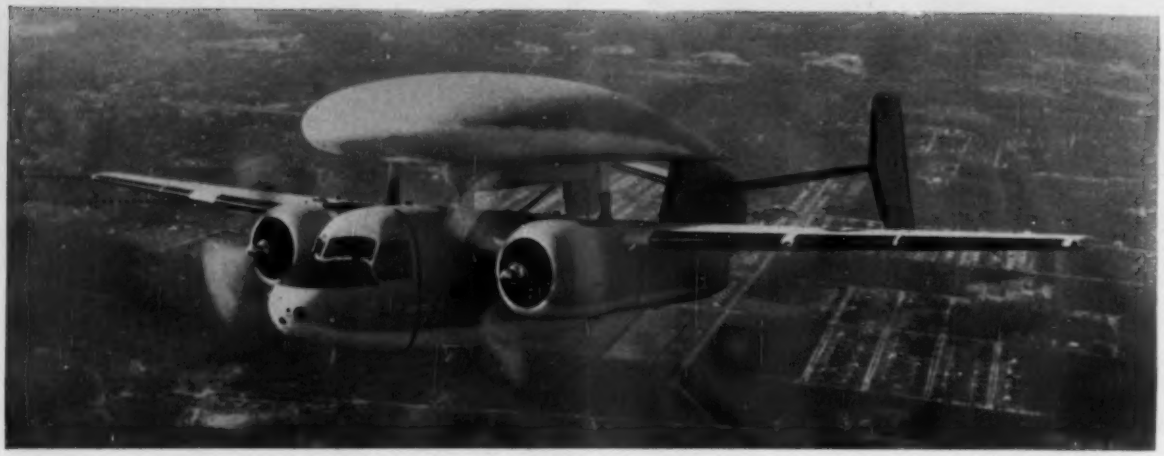
In January a complete financial integration of the aircraft engine and automobile companies belonging to both the Bristol and Hawker Siddeley enterprises was effected. Both organi-



BRISTOL BLOODHOUND

ARMSTRONG WHITWORTH SEASLUG

WESTLAND WESTMINSTER



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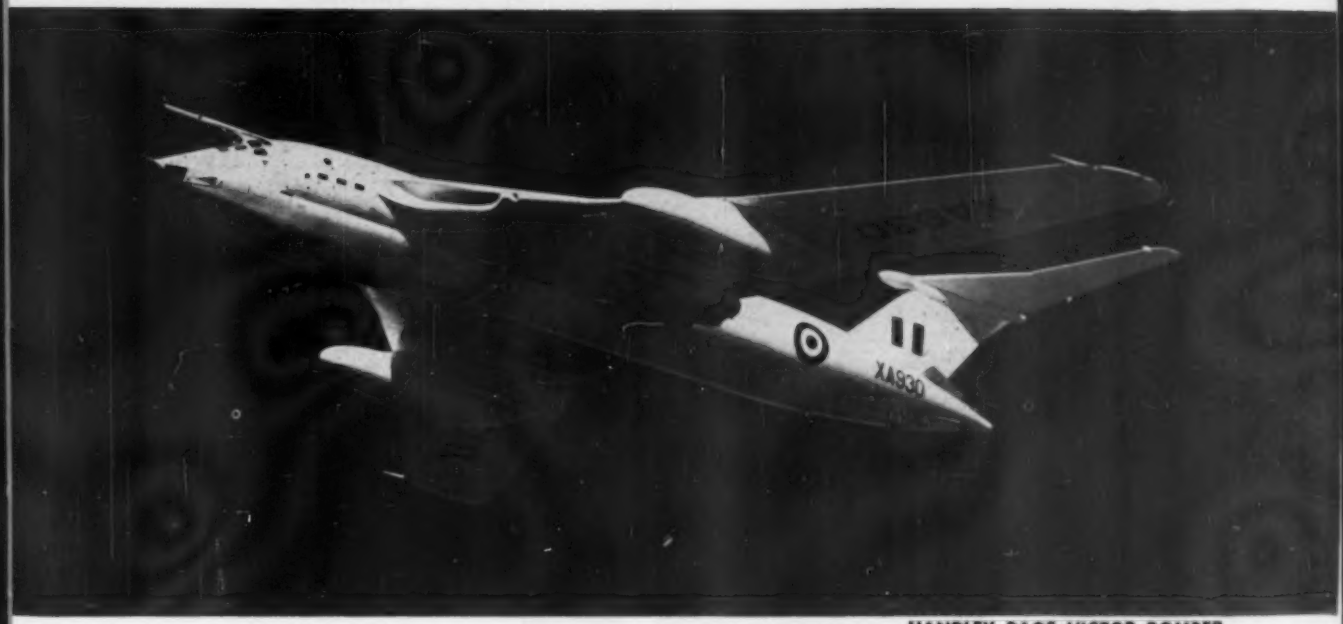

HANDLEY PAGE VICTOR BOMBER

zations dropped their automobile and aircraft interests for a half share in the combined company formed and named Bristol-Siddeley Engines.

The new company becomes the world's third largest aircraft manufacturer and its formation apparently a condition of the award of the TSR. II powerplant contract.

Details of the Vickers-English Electric Aviation partnership formed to undertake the TSR II contract have not been disclosed, but are clearly not so complete. Vickers Armstrongs has the main contract and will house a joint design team at Weybridge where work will proceed on a 50-50 basis. Immediately prior to the award English Electric channelled its aircraft interest into a wholly owned, $17-million subsidiary company and Vickers implemented an extensive reorganization of its design departments.

New Subsidiary

About the same time, Hawker Siddeley Group announced the segregation of industrial and aviation interests and formation of a wholly owned aviation subsidiary, Hawker Siddeley Aviation Ltd.

Complete financial integration of Bristol Aircraft Co. and Short Bros. Ltd. is also considered likely by some observers as a result of current negotiations for the strategic freighter contract. Shorts, currently producing Britannias is two thirds government owned with Bristol and Shorts having a one sixth share holding each.

Partnerships among accessory manufacturers are also under way, notable being the arrangement between the major instrument manufacturers—Smiths Aircraft Instruments, Kelvin and Hughes, and the Sperry Gyroscope Co.—to work together initially on the development of the flight control and instrumentation system for the DH. 121 jet airliner.

Diversification which began with a cautious probe into the nuclear, instrumentation, electronics, hydraulics, servo and computer fields has now the features of a scramble reaching into industrial diesel engines, generators (Hawker Siddeley) and plastics (Bristol).

The same trend, though less conspicuous, applies to the large accessory makers. The Dowty and Joseph Lucas organizations, to quote just two typical examples, are exploiting their fuel pump know-how in the manufacture of competitive, unorthodox hydraulic drive systems for tractors.

These military orders cannot possibly match the decline over the next three years in military exports, and they will hasten rather than halt the unpalatable reorganization of the industry now proceeding. But they are certain to relieve redundancy growths in the worst areas, if this fact is a deciding factor.

Most of the large firms and groups believe there was still enough business left in the pipeline to keep high levels of production throughout this year at least.

Such appraisals, however, are bound to be speculative, for the fate of Britain's aircraft industry depends on the new export potential of the latest tactical and strategic aircraft, helicopters, and missiles as on the sale of her civil aircraft and engines.

Both Handley Page and Avro told AVIATION WEEK that current negotiations are proceeding with a view to the sale of V-bombers to the Commonwealth countries. English Electric retains high hopes for the Lightning which, without autostabilization, demonstrated its ability in an operational configuration to maintain Mach. 2 with minimum afterburning last November.

The British government claims the new TSR II is a better airplane than U.S. counterparts and it will have the most advanced high lift characteristics yet incorporated in any aircraft. The Argosy and the strategic freighter may prove money makers in both military and civil roles. The Rotodyne, which reached a record cruise speed of 190 mph. during investigations of its speed envelope, could produce sales for Fairey.

Missile Exports

British hope missile exports will expand following disclosures of advanced British missile developments, including the Bluestreak, made in December before NATO representatives in Paris. Up to date Sweden has been the only nation to adopt a British missile—the Bristol Bloodhound. The decision to reveal secrets of Britain's missile armory was one long urged by the industry to match the selling facilities enjoyed by U.S. companies.

On the civil side orders for its Britannia, Comet, Vanguard, Argosy, Herald, remained a mere trickle and sales prospects this year show little improvement.

In spite of world wide demonstration tours and the award of CAA certification last year only five Britannia orders

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Size 11 (R860)

Integrating Tachometers, special types of rate generators, are almost invariably provided integrally coupled to a motor. They feature tachometer generators of high output-to-null ratio and are temperature stabilized or compensated for highest accuracy integration, rate computation, etc. In addition to reducing the in-phase null level toward zero, errors due to temperature effects are minimized over a wide ambient range. Linearity, in some cases as low as .01%, is usually better than ±.1%, while phase shift is 0±1°. For extreme accuracy, models with low temperature coefficient drag cups are also available.

Rate Generators feature high output-to-null ratios and are designed for application as rate servos and to provide damping in very high gain systems. These Kearfott units offer high linearity, high output and low inertia and are often integrally coupled to a low inertia motor; in this design the in-phase null is virtually reduced to zero. Quadrature null is as low as .25% of the 1000 rpm outputs while harmonics seldom exceed .1% of the output at 1000 rpm.

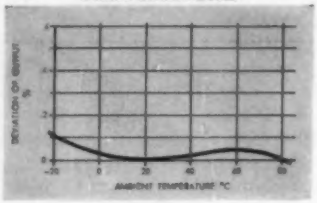
Damping Tachometers have relatively low output-to-null ratios and are designed primarily for damping purposes. They feature extremely low inertia and power consumption, linearity which is normally within ±.5%, and phase shift within 10° of reference. Kearfott damping tachometers are usually integrally coupled to a low inertia motor.

INTEGRATOR TACHOMETERS

(Typical Characteristics)

	Size 11 (R860)	Size 15 (T816)	Size 18 (V892)
Excitation Voltage (400 cps)	115	115	115
Volts at 0 rpm (RMS)	.020	.020	.010
Volts at 1000 rpm (RMS)	2.75	2.7	2.00
Phase shift at 3600 rpm	0°	0°	0°
Linearity at 0-3600 rpm	.07	.06	.07
Operating Temperature Range	−54° + 125°	−54° + 125°	−54° + 125°

TEMPERATURE



RATE TACHOMETERS | DAMPING TACHOMETERS

(Typical Characteristics)

	Size 15 (R800)	Size 18 (V806)	Size 8 (M824)	Size 10 (P822)	Size 11 (R80F)
Excitation Voltage (400 cps)	115	115	26	115	115
Volts at 0 rpm (RMS)	.013	.026	.015	.019	.019
Volts at 1000 rpm (RMS)	3.1	3.0	.234	.450	.5
Phase shift at 3600 rpm	5°	4.5°	10°	5°	5°
Linearity at 0-3600 rpm	.25	.25	.3	.3	.3
Operating Temperature Range	−54° + 100°	−54° + 125°	−54° + 125°	−54° + 125°	−54° + 125°

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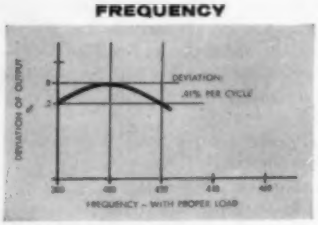
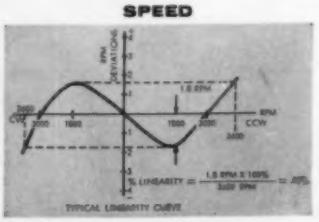


INTEGRAL SERVO MOTOR DATA

(Typical Characteristics)

	Size 8	Size 10	Size 11	Size 15	Size 18
No Load Speed (RPM)	5400	6600	5500	8000	8000
Stall Torque (oz. in.)	.3	.35	.55	.45	1.30
Excitation Voltage (400 cps)	18-40	26-40/20	115-40/20	115-40/20	115-115/57.5
Rotor Moment of Inertia (Gm.CM²)	1.3	.76	7.7	7.0	35
Operating Temperature Range	−54° + 100°	−54° + 125°	−54° + 125°	−54° + 125°	−54° + 125°
Unit Weight (incl. tachometer)—oz.	3.1	4.6	9.0	14.0	30

SPEED



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were secured during the year and the shadow of immediate large scale layoffs among airframe workers loomed closer at both Filton and Belfast. The break-even number of this aircraft due to Proteus icing troubles has now crept to around 100. Yet orders total 79 of which 50 have been delivered.

Most of the remaining aircraft will go to the RAF and will be made at Belfast but five will be shipped for assembly at Filton to help out. Firm sales prospects so far do not exceed five and Bristol particularly is faced with a reduction of 1000 (10%) airframe workers by June and thereafter reductions will become drastic.

Britannic Wins

Both companies have submitted Britannia conversions in a bid for the strategic freighter award but the version favored was the Short Britannic which incorporate a much larger fuselage of 10 ft. diameter.

The flight deck equipment, systems, tail unit and the wing are those of the Britannia. A high wing configuration has been chosen with an undercarriage mounted on the fuselage and retracting into side blisters. Maximum payload is 60,000 lb.; gross weight 180,000 lb. An ultimate stretch in four stages to a gross weight of 220,000 lb. is envisaged, switching finally to a thin high aspect ratio wing, a lengthened fuselage and Mark II Tyne engines.

In the helicopter field, Bristol secured no further orders for the Gazelle turbine powered 192 twin rotor helicopter or the Sycamore. Deliveries to the RAF of an order for around 30 aircraft begin shortly.

Napier failed to collect any further orders for Eland conversion. Handicapping Napier's sales effort was the delayed certification of the aircraft to U.S. standards due mainly to brake inadequacy at the increased gross weight of the converted aircraft. Aircraft converted in the U.S. will have Goodrich brakes.

Fire Damage

With this modification the airplane was finally awarded CAA certification in December. Soon after the brake modifications had been fitted in the U.S. the company's demonstration Convair suffered serious fire damage when a hydraulic surge in the brake system spilled fluid over both drums after a landing run.

Conversion of REAL's three Convairs was held up by lack of sterling and has only recently been resumed. One of the 10 Eland-engined Canadair CL-66s has flown at Canadair's Montreal plant.

Napier is hoping it will do business in converting some of the 3,500

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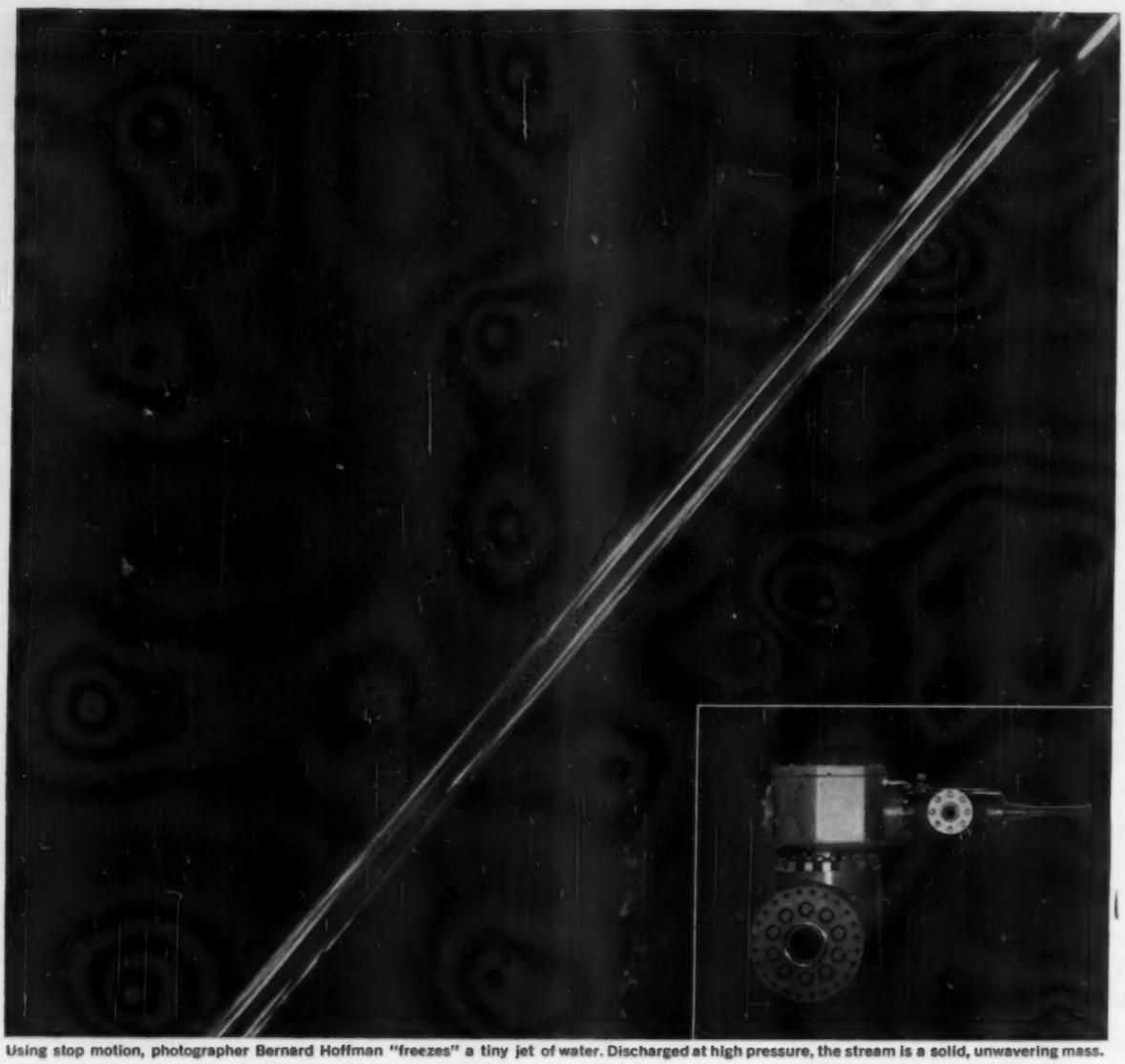

Using stop motion, photographer Bernard Hoffman "freezes" a tiny jet of water. Discharged at high pressure, the stream is a solid, unwavering mass.

SPLIT-SECOND CONTROL OF TIME AND PRESSURE

Take the valve pictured above. This 10-inch, high-speed Rotovalve was designed for rapid flow control at a Langley Field test installation. It will fully open, or close, in one-tenth of a second against water under free-discharge conditions at 3,260 pounds per square inch pressure.

How much pressure is involved in your application? How fast must you operate? What's the volume? Dozens of questions must be considered to relate all the factors that influence a fluid control problem. They require specialized engineering . . . the kind you get from Allis-Chalmers.

A-C Rotovalves may be your answer. Their full-line opening offers no obstruction to flow. They may be designed to give you extremely close control of closing time. Positive closure gives completely tight shut-off against either pressure or vacuum.

If you have a fluid control problem, A-C offers you a broad background of specialized valve engineering and application skills. To find out more about how we might assist you, contact your nearest A-C representative, or write Allis-Chalmers, Hydraulic Division, York, Penna.

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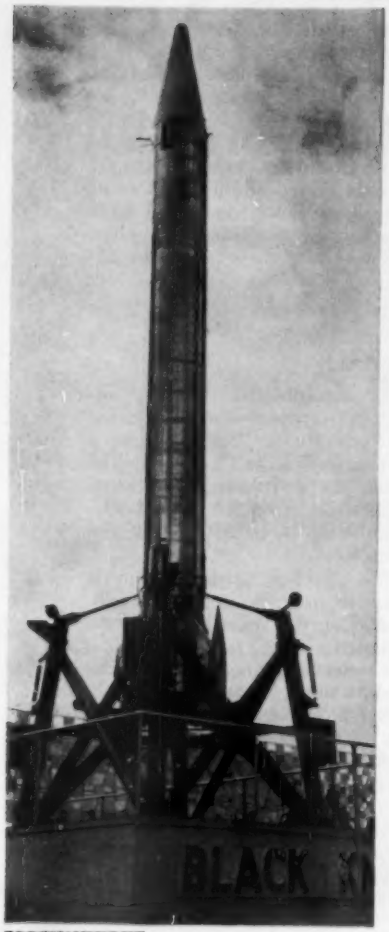

BLACK KNIGHT

piston-engined aircraft which might become surplus in the near future. Because of the drastic drop in the market value of these airplanes Napier maintains it can convert and recommission them for a reselling price even lower than the normal second-hand market value. Passenger seat mile costs of the converted aircraft are between 5-10% lower.

Likely resale prices could be $1 million for a four-engined aircraft.

Herald Fire

There were no sales for the Handley Page Herald either, although New Zealand Airways has shown keen interest in the Dart powered airliner. Handley Page's development plans were further upset when its first prototype, nearing certification, crashed en route to the Farnborough Air Show and provided one of the most dramatic belly landings since the war. An oil starved rotor bearing, due to faulty oil pump gearing, led to disintegration of the turbine rotor which severed fuel lines causing a structural fire stretching from wing to tail and almost total loss of elevator control.

Second prototype flew in January and

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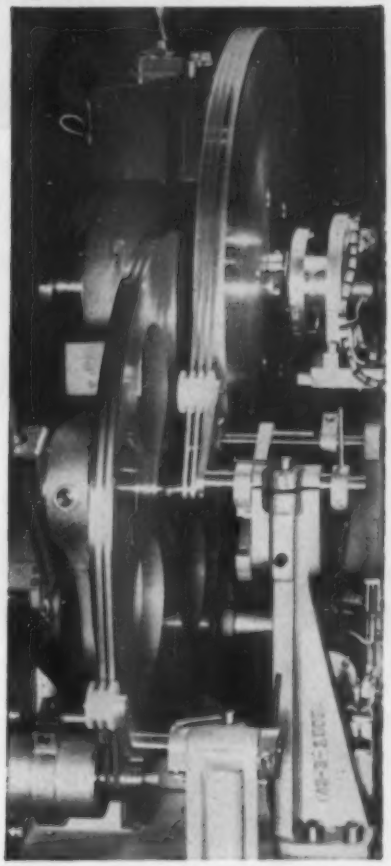
NEW Low-Noise Memory Drum Drive



This stainless steel belt drive was developed to reduce the noise of instantaneous speed variations and backlash inherent in gear drives.

In actual tests with FM recorded data, the noise level was four to six decibels lower than the finest gear drives available for comparison. Signal-to-noise ratios of over 60 db (with noise cancellation) have been measured.

Unusually durable, this stainless steel belt drive holds its low noise level for years.

While this drive is for a special-purpose magnetic memory drum, similar drives can be designed for any memory drum or tape transport.

This precision component is just one example of the specialized engineering and production skills to be found at Clevite, Texas Division. We are producing complete analog computer systems with an overall accuracy of 1 part in 6000. We are also equipped to design and build sub-systems and computer-controlled servo systems to any specification.

If you want to know more about us and what we can do, just write. We will be glad to send you our brochure describing facilities or arrange for an appointment at your convenience.

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If you have a difficult fluorocarbon problem, why not send it to your local Garlock office for quotation? Guarantee yourself the best in parts, methods, and price.

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Plastics Division of GARLOCK

is due to go straight into a series of world demonstrations. Company investment in the Herald project amounts to $14 million.

Handley Page could also be the beneficiary of one or more of the boundary layer control contracts currently thought to be under consideration. This company has been closely associated with laminar flow sucked boundary layer control using a gloved wing Vampire aircraft, and has long been confident that the method was adequately proven for commercial exploitation.

Design Study

In the autumn the company announced the completion of a detailed design study for a 12-seat executive type airliner called the C. 113. It had a sucked, swept laminar flow wing, gross weight of 36,000 lb. and two Orpheus turbojets mounted in the rear of the fuselage.

But this relatively small company is not likely to have the necessary facilities to develop the aircraft as a strictly private venture.

The Comet made its return debut in April and staged an aggressive comeback over the Atlantic Ocean by opening the first transatlantic jet service simultaneously from both sides. It since has been operating at about 80% load factor.

But in spite of the publicity, few new orders followed.

Thirty-three have been ordered, and eight delivered including the first of six to Aerolineas Argentinas. Negotiations are currently proceeding with 20 operators, and the makers were distinctly more optimistic about its immediate sales prospects than most of the turboprop manufacturers.

Intercity Densities

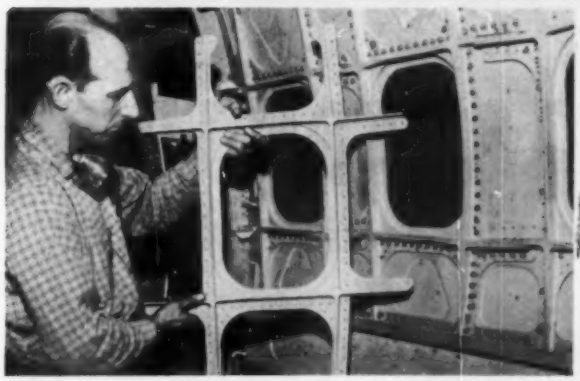
This was particularly true in respect to Middle East operators. De Havilland believes its medium size jet can handle the modest intercity traffic densities there with attractive frequencies and profitable payloads. Sale prospects of 10 Comets to Canadian Pacific Airways toppled when the airline gained permission to operate only one of the new routes applied for. The Argentine airlines, which hopes to operate Comets into New York next month, triggered Pan American into fresh appraisals of the aircraft, but de Havilland would make no comment on the proceedings. Air Commodore Juan Jose Guiraldes, president of Aerolineas Argentinas, commenting on its choice of aircraft, said there was not enough business to keep the bigger U. S. jets going.

The Armstrong Whitworth Argosy made its first flight in January and the company by June intends to take the fourth aircraft on a world tour after a Paris show debut. The company ex-

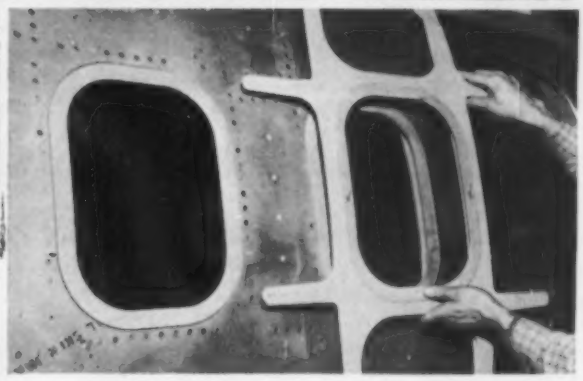
99 Ways to make a Jet Flagship Stronger—with Bridgeport Aluminum Forgings!

This big, beautiful Boeing Jet Flagship sports 99 windows—and every one of them must be able to withstand the stresses set up by superspeed high-altitude jet flight.

Quite a challenge! Yet Bridgeport's husky aluminum hand forgings machine down to lightweight, six-to-eight-pound window frames having the necessary stress and fatigue resistance.



In the Boeing Jet Flagship, these flawless forgings are interlocked to form a significant structural contribution to hull strength.



This windowframe fabrication method offers an unusual combination of lightness, strength and construction economy!

These vital forgings are only one example of how Bridgeport's resources and ingenuity contribute to solving construction and fabrication problems in aluminum. Custom extrusions, die forgings and a wide range of standard extrusions, bars, tubes and coiled sheet are available from Bridgeport in aluminum alloys meeting every application requirement. For help on either routine or "problem" aluminum construction—call on Bridgeport. (Dept. 1201)

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This new TONOTRON tube provides high light output, integration abilities, full gray scale, controllable persistence, and a very large display area—all in one envelope!

Hughes also announces a 21" character-writing TYPOTRON* storage tube, which gives you the *added* capability of high-speed digital character display. The 21" TYPOTRON tube is ideally suited for any of your digital read-out requirements. In addition, this unique TYPOTRON tube offers you either character read-out or spot writing modes—or a combination of both capabilities.

Both the 21" TONOTRON Tube and the 21" TYPOTRON tube are now available for delivery. For additional information please write: Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, California.

See the new Hughes 21" TONOTRON tube in action at the I.R.E. show (Booths 2801-2807)

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pects to sell at at least 30 with options this year.

Vanguard made its maiden flight in January.

Vickers sold 30 Viscounts during the year—a marked improvement on the previous year—bringing the Viscount order book to 405 with 105 still to deliver. The local service version didn't sell and has been put on ice. Vickers feels it may be a little ahead of the market as many small airlines have yet to be sold on the turboprop business.

Vickers gained no further Vanguard orders during the year but feels an order book standing at 40 for an aircraft that has only just made its first flight is not desperate.

The company is confident that it will score in a number of countries with the Viscount 810. A Continental Air Lines' six month operation cost analysis shows figures even lower than Vickers claims, with passenger seat mile costs only half those currently applying with Continental's DC-3 fleet. The Viscount figures are 1.4 cents compared with 1.66 for the DC-7, 1.83 for the DC-6 and 1.95 with the Convair.

Viscount Demonstration

A Viscount demonstration tour inside the Iron Curtain last November also proved encouraging according to Vickers. LOT, the Polish airline, feels the aircraft is technically suitable and negotiations are currently proceeding at government level.

Fairey succeeded in selling six Rotodynes to British European Airways which has an option of 20 more if the makers comply with rotor-jet silencing and size requirements. BEA is also likely to be insistent on the installation of Rolls-Royce Tyne engines instead of Elands. Manufacturing rights in the U.S. have been secured by the Kaman Aircraft Co.

At home, Fairey has still failed to resolve the issue of a development cost contribution from the Government. The aircraft is currently undergoing structural modifications which will improve the handling characteristics at speeds much higher than the original cruising speed of 160 kt. Among them is a reduction in wing incidence.

Reported to be competing for the Army helicopter requirement also is the Westland Westminster. This single rotor helicopter with twin Eland gas turbines made its first flight during the year and can carry 46 passengers.

Sales of light aircraft fared little better than their bigger cousins. Scottish Aviation flew two Twin Pioneers in different directions round the world and sold five, bringing its total order book to 69 with 29 still to deliver. Lack of sterling, inferior credit terms are blamed for the poor response in South America. United States certification due

SAUNDERS-ROE P.531

ARMSTRONG WHITWORTH ARGOSY

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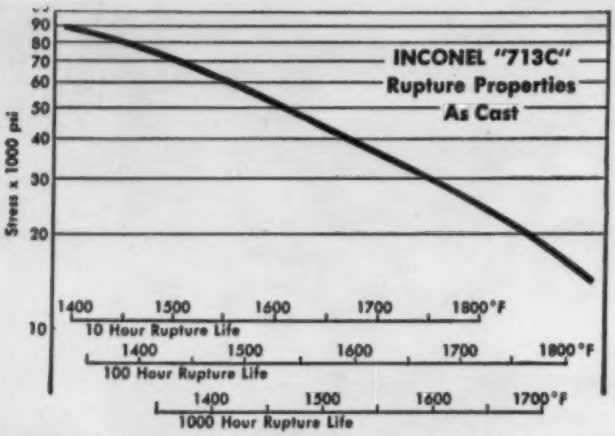
● BRITAIN



Graph shows the 10-hour, 100-hour and 1000-hour rupture strength that Inconel "713C" provides at 1700°F

New cast alloy! New rupture strength!

Now aircraft and missile designers have a new alloy to work with:— Inconel "713C"* nickel-chromium cast alloy.

Inco developed it especially for high temperature investment cast parts in advanced jet aircraft and missile hardware.

Basically, Inconel "713C" alloy combines outstanding rupture strength at 1700°F (see graph) with excellent resistance to thermal fatigue and good castability.

Other new high temperature alloys developed by Inco

In addition to Inconel "713C", Inco has developed a number of other new high temperature alloys which may well be the answer to material-selection problems in missile design. They include: Incoloy "T" titanium-containing nickel-iron-chromium alloy, Incoloy "901"* nickel-iron-chromium alloy, Inconel "700"* age-hardenable nickel-cobalt-chromium alloy and Inconel "702"* aluminum-containing nickel-chromium alloy. For comprehensive data on these new nickel alloys, write to:

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this spring is expected to boost sales in both Canada and Africa.

Development plans for the company include possible conversion of the Twin Pioneer to gas turbines.

Hunting took the Jet Provost on an extensive tour of South American countries, trying to sell the aeroplane and the idea that goes with it—straight through jet training. At home, the company received a very substantial order from the RAF, which is the first air force to adopt straight through jet pilot training. In RAF evaluation courses, pupils without previous flying experience averaged 10 hr. before first solo, a figure very close to piston engine time-to-solo figures. Primary jet trainers cost more in fuel, but there are net savings reports the RAF, as Provost's Viper jet engines are cheaper to maintain and later training on advanced military aircraft is shorter. Number of Jet Provosts involved has not been stated but it is not likely to fall much short of the 300/400 piston-engined Provosts in service with the RAF.

Black Knight Fired

Highlighting missile development in Britain was the successful first firing of the Black Knight re-entry test vehicle which achieved a height exceeding 50 mi. Although a relatively modest venture, British scientists were generally credited for achieving so much for so little outlay in time and cash. Total expenditure did not exceed $14 million. Engineering details recently disclosed, show total thrust to be 16,400 lb., confirmed the use of four rocket motors each independently mounted on trunnions and pivoting in diametrically opposite pairs to provide pitching and yawing guidance.

De Havilland Propellers Ltd. is currently recruiting staff for the automatic prelaunch systems checking equipment and in-flight safety system for the Blue Streak ballistic missile, and recent reports have stated that test firing near Woomera may begin later this year.

According to English Electric, work is proceeding on the Mark I Thunderbird for the army but reliable sources indicate that the RAF has rejected the missile. Current issue appears to be whether the RAF will accept the second generation missile from English Electric Aviation in preference to Mark II Bristol Bloodhound. English Electric claims to have fired its Mk. II already. The Bristol weapon is said to be still under development. Observers have been saying for some time that of the first generation missiles, the Bloodhound is more successful than the Thunderbird.

Fundamental difference between the two generations of each weapon is a switch from pulse to continuous wave radar systems which gives added range and improved anti-jamming features.

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For accurate gyro indications, gimbals need bearings with uniformly low and predictable torque reactions. Other demands are extreme accuracy of rotation and exact positioning of the gimbal.

All standard *Barden Precision* bearings meet critical requirements for low torque and rotational accuracy. In addition, the special purpose Z96SW has these important design features:

Barden-developed "W" retainer—to minimize torque peaks . . . eliminate "windup"

Precision flange—for precise positioning and alignment . . . rigid mounting

Shield on exposed side—to prevent entrance of foreign matter

One of hundreds of Barden "specials," the Z96SW is an example of the results that stem from working creatively with Barden engineers from the earliest design stage.

Like all *Barden Precision* bearings, standard or special purpose, the Z96SW is planned for *performance* from research and design, through quality controlled production, functional testing and application engineering.

Your product needs *Barden Precision* if it has critical requirements for accuracy, low torque or low vibration . . . if it operates at extreme temperatures or high speed.

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NORD GRIFFON

DASSAULT MIRAGE III

'Algeria First' Stalls French Air Pace

By Robert Farrell

Paris—Unrealistic government airpower policies continued to plague the French aircraft industry during 1958.

"It was a year," as one company official put it, "that we'd like to forget." Behind the familiar tale of costly production stretchouts and the near total absence of French NATO airpower loomed the same old problem: Algeria. Demand by Army and Air Force for men and equipment to carry out operations against persistent Algerian rebels meant another year of delay.

Industry, besides being hampered by a thin budget at home, also suffered setbacks in its attempt to gain foreign markets for new French designs. French had hoped to sell Europe on Dassault's Mirage III interceptor and Breguet's Taon strike fighter. But by the end of 1958, France admitted failure. Thus the only export successes during the year were turned in by proven equipment as the Caravelle, the Noratlas transport, the Magister jet trainer and the Alouette helicopter.

Clearly, the French aircraft industry is in a period of transition. Caravelle aside, most of the big production runs now in progress—Noratlas, Magister, Super-Mystere, Vautour—are due to wind up over the next 18 months. They'd be over sooner if production stretch-outs weren't in force. Yet few new production orders have been placed to fill the looming gap.

No relief is to be found in the 1959 budget. This is frankly labeled transitional, designed "just to keep things going." Meantime the new Gaullist regime is putting together a five-year program (1960-64) which is supposed to give industry a better look at its future.

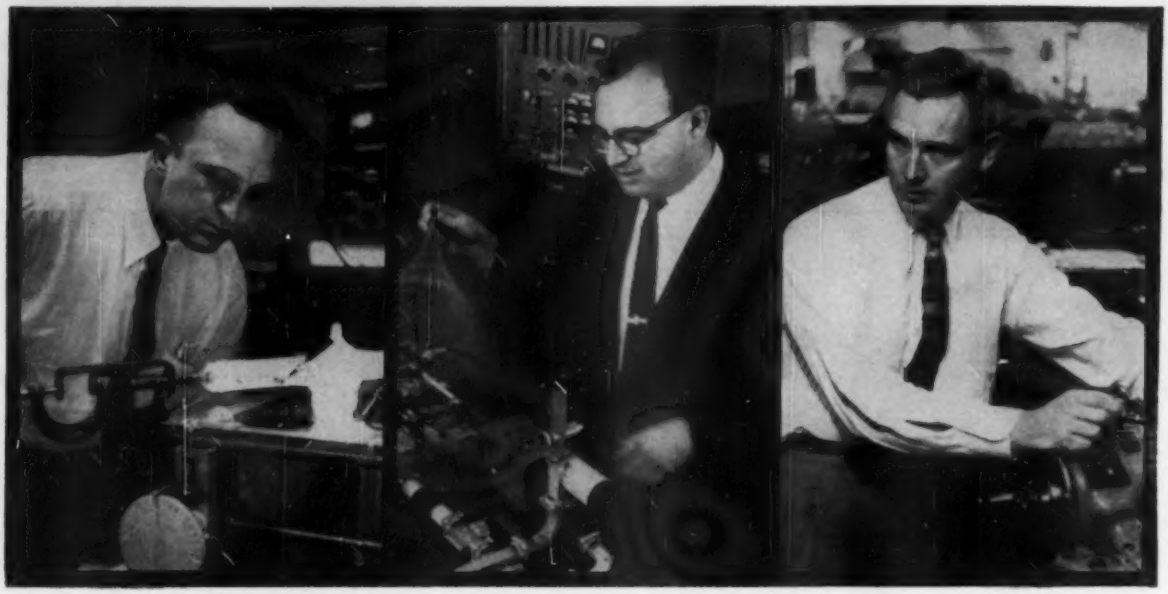
Not much is known about what sort of future the plan will hold out to industry. But whatever policy emerges, many industry observers are convinced it won't eliminate the basic fault of French airpower policy to date. This is simply that French governments over the years have expected too much from the French air force and its industry supplier. No member of the Western Alliance attempts to spread its airpower effort as thin as the French do. It isn't expected that a Gaullist government will display more realism on this point than the cabinets of the Fourth Republic.

Thus the new policy probably will confirm the following missions for the air force:

- **Defense of French interests** in its "community" overseas. This means being prepared to fight wars of the Algerian type.
- **Maintenance of French NATO** airpower. This means continued phasing into French air force wings of advanced type aircraft, preferably designed and built in France, as well as tactical missiles.
- **Development of strategic** capability. This means development of a costly nuclear weapon system, either based on

3=1

3 thoroughly competent departments—Research, Engineering and Manufacturing—equal one complete systems capability. The Mechanical Division of General Mills is your single source for technical problem-solving!



Left—*Dr. John Barkley*, Director of Research, heads the department that moves from hypotheses to facts, clarifying the present, probing the future, recording findings for comparison and evaluation.

Center—*Dr. Howard Baller*, Director of Engineering. His department gives substance to ideas, showing *how* these ideas can be converted into practical military and industrial products.

Right—*Kenneth J. Carlson*, Director of Manufacturing, and his men transform theories and designs into physical realities, utilizing the skills of all three departments to meet every production requirement—*on schedule!*

Mechanical Division teamwork plays a vital role in *all* our current activities, including: *Search and Track Systems* (infrared optics, visual optics, radar, antennas, slave platforms) *Guidance and Navigation Systems* (computers, and inertial or navigational platforms) *Underwater Ordnance Weapons* (torpedoes, depth charges and related mechanisms) and *Missile Sub-Systems* (mechanical, electro-mechanical or electronic controls). *For complete details, address inquiries to: Dept. AW-12,*

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an aircraft or ballistic missile delivery system, but in any case French-designed and built.

Besides meeting these three air force requirements, industry is also attempting to capture civil markets with aircraft as the Caravelle, a project which is beginning to absorb nearly one-third of the industry's potential. With just so much production capacity and government development funds available, it seems obvious to many observers that the French, sooner or later, will have to scale down their ambitions. In practice, of course, this is what happens. For lack of funds, promising prototypes are shelved and production schedules are stretched out.

Algerian Drain

First air force mission, defending French interests in Algeria, has required considerable numbers of aircraft ranging from Piper Cubs to surplus U. S. bombers. The air force mans hundreds of T-6 "fighters" in Algeria along with several hundred U. S. and French helicopters, all of course requiring air crews and fuel which have to come from somewhere. Money made available in 1959 budget for new aircraft reflects French intention of maintaining this overseas mission. Thirty Douglas B-26 bombers will be bought for use in Algeria along with a dozen C-47s.

The Air Ministry also earmarked $6 million for continued prototype work on Sud Aviation's liaison aircraft, the twin-turboprop Voltigeur, designed specifically with Algerian military needs in mind. During the year three other companies, SIPA, Morane-Saulnier and Dassault, also worked on prototypes to meet this need, but Sud won the competition.

The air force's second mission—maintaining French airpower within NATO—was severely hobbled during 1958 by air force efforts in Algeria. Thousands of airmen were shifted from NATO posts into infantry ranks in Algeria. Jet pilots were pulled out of European units and set to flying T-6 and Republic P-47 missions against rebel bands. Louis Christiaens, then Air Minister, warned early in 1958 that French units in Europe would have to stay on the ground unless funds for fuel were found somewhere. Finally, the air force's 1958 budget cut of 25% led to resignations of the air chief of staff and the Air Ministry's top technical director.

Under the 1959 budget, the situation remains about the same, though the air force, on paper, has improved its front-line fighting ability. During the year two squadrons, about 50 aircraft, of North American F-100Cs were turned over to the French under U. S. military aid programs. The air force also took delivery of 100 Dassault Super-Mystere B2s powered by Snecma

RMC-LINDSAY ONLY GAUGE TO STAND THIS TEST — This photograph shows vibration testing of RMC-Lindsay pressure gauges on the 3200 force pounds Calidyne Vibrator to 50 G output, amplitude .010 to .20. Cycling frequencies to 2,000 cps. The test is conducted so as to parallel actual installation conditions, with gauges subjected to 350°F under operating pressures. Complete test reports are available on request.

THE RMC-LINDSAY GAUGE IS RADICALLY DIFFERENT

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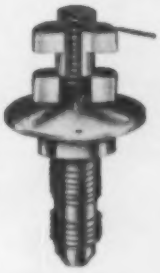

1. **The RMC-Lindsay gauge is a multiple coil, helical bourdon tube type, *restricted for overpressure.***
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3. **Superior techniques in coiling, heat treatment, calibration, and material specification are *new* and *exclusive* with RMC.**
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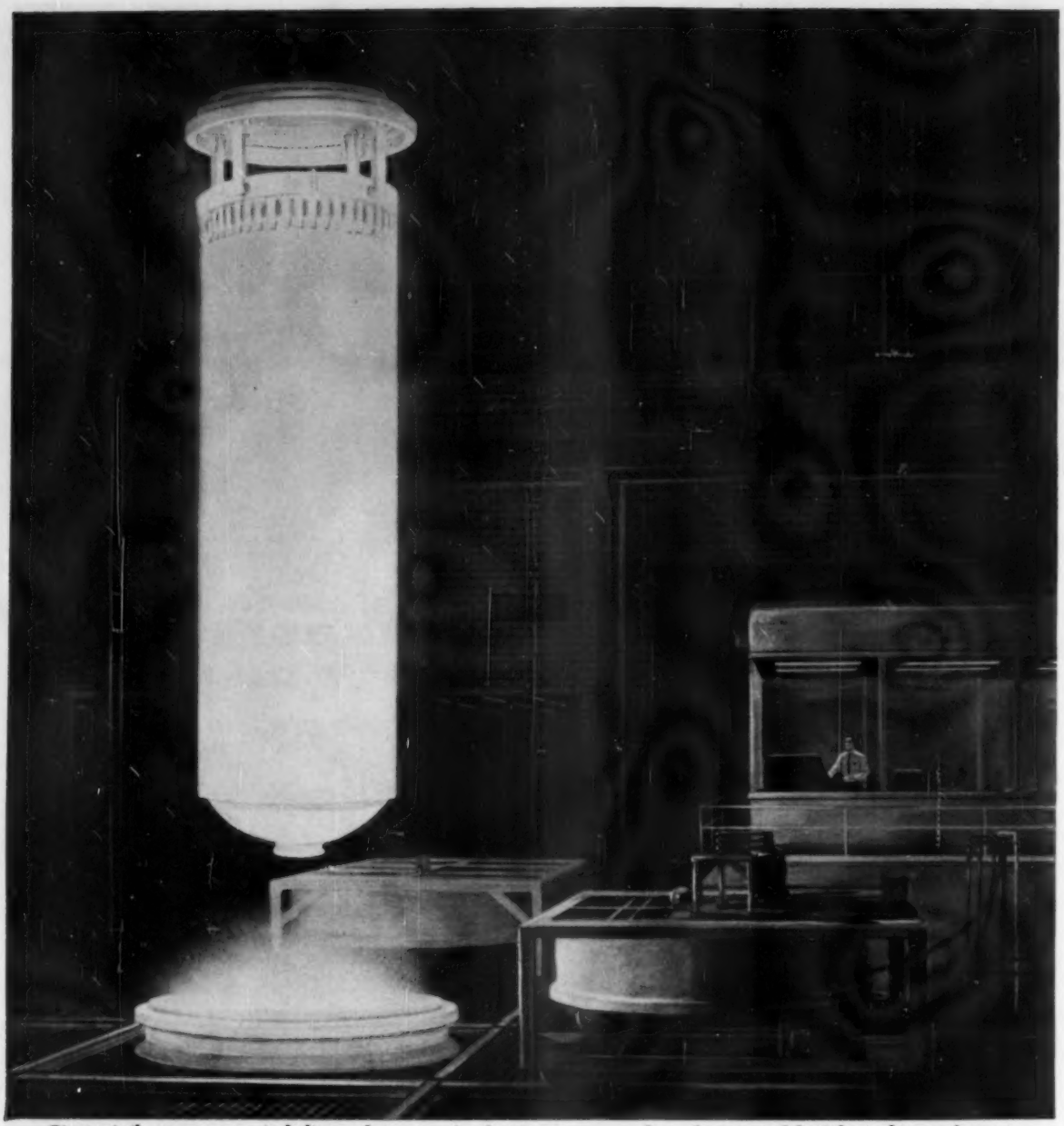

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Atar G turbojets delivering 9,900 lb. thrust with afterburner. An additional 50 are slated for delivery this year. This year the air force will finish phasing in Sud Aviation's Vautour, of which 160 were finally ordered in three versions, 30 ground-attack, 70 night fighter and 60 bomber. About 25 of the bomber version, however, have been sold to the Israeli Air Force. The air force's original Vautour order was for 360 aircraft.

Any new additions to French NATO airpower, barring further U. S. military aid, won't come until late 1961. The air force, after announcing its intention to order the Dassault Mirage IIIA, didn't put up the money until late 1958. Initial order is for 100 aircraft, with the first production model slated to roll out in September, 1960. Dassault hopes to be building the Mirage at a rate of nine per month by mid-1961.

Mirage Market

Mirage IIIA is powered by a Snecma Atar 9 afterburning turbojet engine producing 13,200 lb. thrust plus a SEPR rocket engine of 3,300 lb. thrust, the rocket used in the interceptor configuration. Failure of French to interest West Germany in the Mirage probably means other export possibilities won't materialize. French were hoping on a larger market for the Mirage.

Other than the Super-Mystere and Mirage, the air force has shown little financial interest in other types of manned front-line aircraft. Ironically, the air force still refuses to put any money into lightweight fighters despite the variety of existing French designs of this type. French dropped their earlier intention of ordering 48 Fiat G. 91 strike fighters when they learned their Breguet Taon strike fighter, slated to be ordered as NATO's second generation lightweight fighter, will be bypassed by NATO in favor of a third generation aircraft, probably a VTOL or STOL type.

Bulk of air force transport is handled by Nord Aviation's twin-engine Noratlas aircraft, of which 200 have been ordered and mostly delivered. Nord is working with German interests on the development of a turboprop successor to the Noratlas, which is also being delivered to the German Air Force in quantity. The new transport, if built, will be powered by two Rolls-Royce Tyne engines. Maximum gross weight reportedly will be 99,000 lb. and payload will be 17,600 lb. The air force also is taking delivery of its four Breguet 675 Sahara cargo transports. Sahara is a modified version of Breguet's 763 Deux Ponts. The air force originally ordered 15 Saharas, then last year cut the order back to four.

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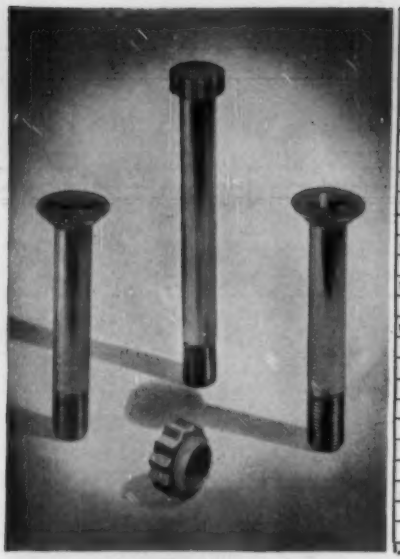

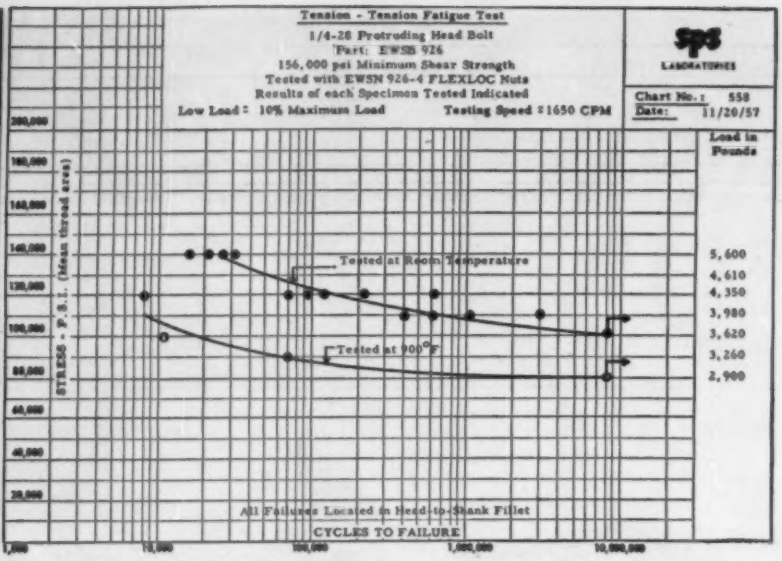

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DASSAULT ETENDARD IVM

mental cargo-passenger transport which flew for the first time last May. Aircraft is powered by four Turbomeca Turmo II turboprops of 400 eshp. each and uses blown-wing principles for short takeoff runs. Breguet plans to build a larger version—the 941—of 18 tons with a 9 ton payload. Engines would be four General Electric T-58s. Company, through its technical agreement with Piasecki, hopes to get U. S. backing.

The air force's third mission—development of strategic striking power—is still a long way off. De Gaulle's government, like other government's before his, doesn't want to man U. S. IRBMs unless control over the nuclear warhead is French-held. Since the U.S. refuses this, the French continue to push on with development of a nuclear weapon system. French ability to explode a low yield nuclear device probably exists today, or is very near. But the French realize there is a long and expensive road between exploding a cumbersome nuclear device in the Sahara and the possession of a nuclear weapon system capable of attacking a target several thousand miles away. Nonetheless, the French appear determined to make the effort.

While work continues on the nuclear bomb, French still haven't decided on its vehicle. Dassault's Mirage IV, twin-jet two-place bomber capable of flying at Mach 2 plus, won't fit the requirement. Mirage IV was slated to be powered by two Snecma Super-Atars capable of delivering from 18,000 to 20,000 lb. of thrust each. French now intend to use the Mirage IV, powered by two Atar 9s, as a development vehicle for a larger, probably Mach 3, bomber. First flight of the Mirage IV with its Atar 9s is slated for this month. Final version of the Mirage Mach 3 bomber is probably three to five years distant, at which time the French hope to have refined their atomic bomb.

Powerplants of the Mirage Mach 3 bomber probably will be turbojets, either French or foreign, but there is some talk that the air force remains interested in a ramjet-turbojet combination. Such talk is bolstered by fact that Nord's ramjet-turbojet experimental interceptor, Griffon 2, is still supported by Air Ministry, though not very handsomely. The Griffon, of which only one prototype exists, completed during the year a series of flight tests which carried the aircraft to Mach 2.1. It will be used to continue studies on this combined form of high-speed propulsion.

IRBM development is still in the study stage. During the year several French companies, mostly aviation and chemical, formed a group—France-Rockets—with the aim of studying problems of building IRBM type weapons in France. Many industry officials, more aware of the industry's limited potential than most government leaders are, conclude France shouldn't attempt to go into the IRBM building business.

Missile Progress

French development of smaller missiles, however, has been fairly successful. Nord Aviation enjoyed considerable success with its SS.10 and SS.11 anti-tank, wire-guided missiles. In addition to European orders, Nord received a substantial order during the year for SS.10s from U.S. Army, and hopes to get the SS.10 accepted as the standard U.S. Army anti-tank weapon. In this case the missile would be built in the U.S.

Nord also is producing large quantities of its 5103 air-to-air missile for alr

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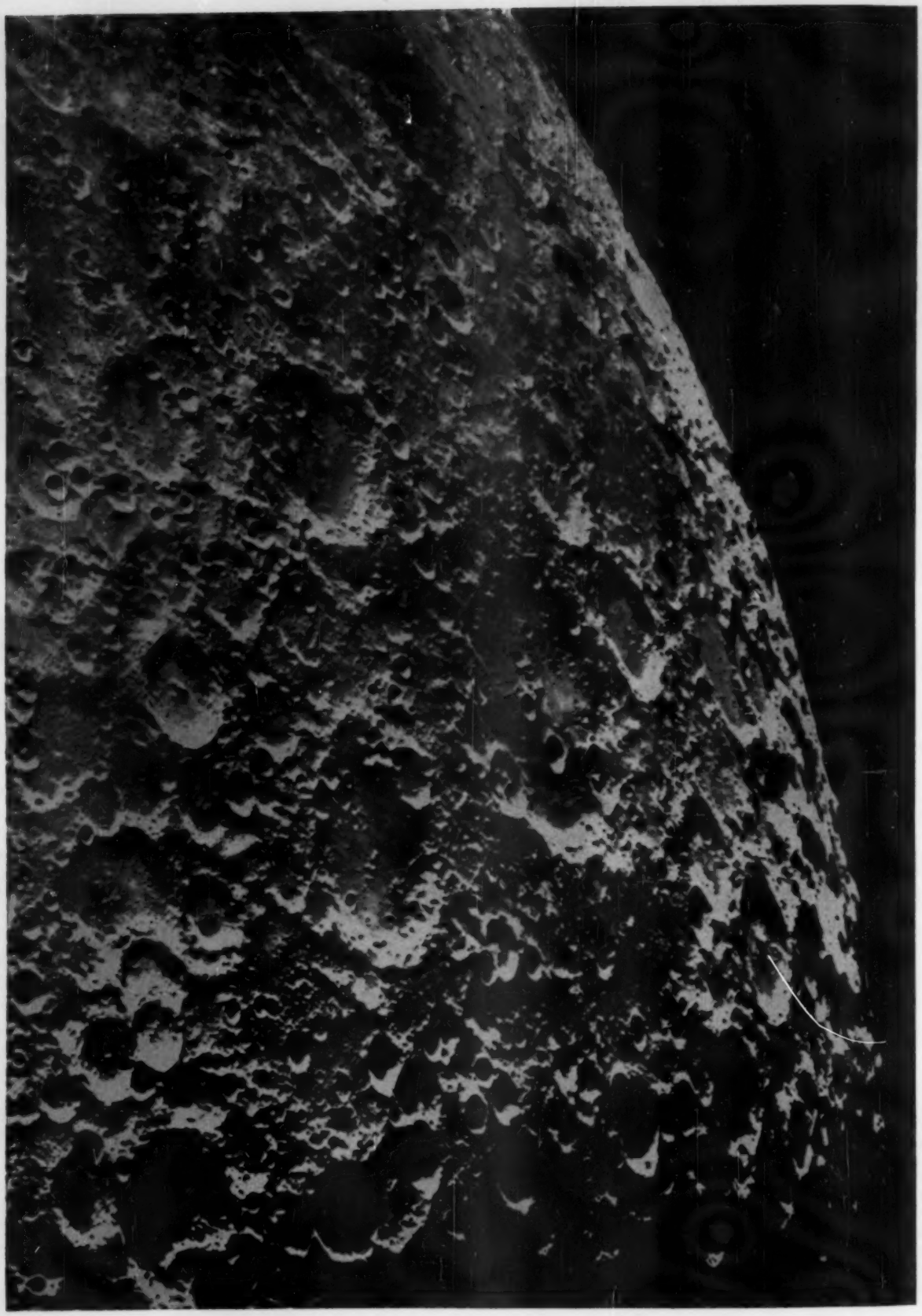

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force use as well as some NATO sales. The missile is about 8.5 ft. in length, weighs just under 300 lb. Guidance is by radio. Second French air-to-air missile, being turned out in smaller quantities, is the Matra 510 which weighs about 375 lb. and flies at Mach 2.

French are also working on several types of tactical and defense type missiles about which little is known. Sud Aviation reportedly is turning out production quantities of a tactical ground-to-ground missile called the Smasher. The missile currently is being phased into an Army unit in North Africa. Nord is working on a ramjet anti-aircraft missile, but no information is available. Company is testing a new twin-ramjet Mach 2.5 target missile. This will replace its turbojet CT-20 target missile which has been produced in quantity.

Together with four other NATO European nations, the French expect to build the Army-Raytheon Hawk low-altitude air defense missile, though many French industry officials are unhappy about the deal. They would rather see U.S.-backing for European production of a European-designed missile. It isn't likely the French Defens Ministry can finance Hawk productio without cutting back on certain Frenc projects. French Army, however, wante the Hawk.

Navy Ambitions

In contrast to the air forces' multi-mission outlook, the French naval air arm continues to keep its ambitions rather restricted. It is still waiting for its first postwar aircraft carriers—the Clemenceau and Foch—whose construction has been delayed for lack of funds. New Navy equipment on order includes 75 Breguet Alize three-place anti-sub aircraft powered by a single Rolls-Royce Dart turboprop. Five pre-production Alizes have been built, and delivery of first production model is scheduled for May. Navy also wants to order at least 50 Dassault Etendard IVM single-seater attack aircraft, but as yet hasn't been able to find the necessary funds. Etendard IVM is powered by a Snecma Atar 8 delivering 9,700 lb. thrust. Navy also has ordered 30 carrier versions of Fouga's jet trainer, the Magister.

Still in the planning stage for the navy is a helicopter-carrier and several missile launching ships.

Navy ASW projects center mainly on the current NATO competition under which Breguet's turboprop paper project may be built by several NATO nations. The Breguet ASW aircraft would be in the 38-ton class and be powered by two Rolls-Royce Tyne turboprops. Scheme is being held up by lack of financing. Meantime navy this year is taking delivery of ten Martin P5M-2

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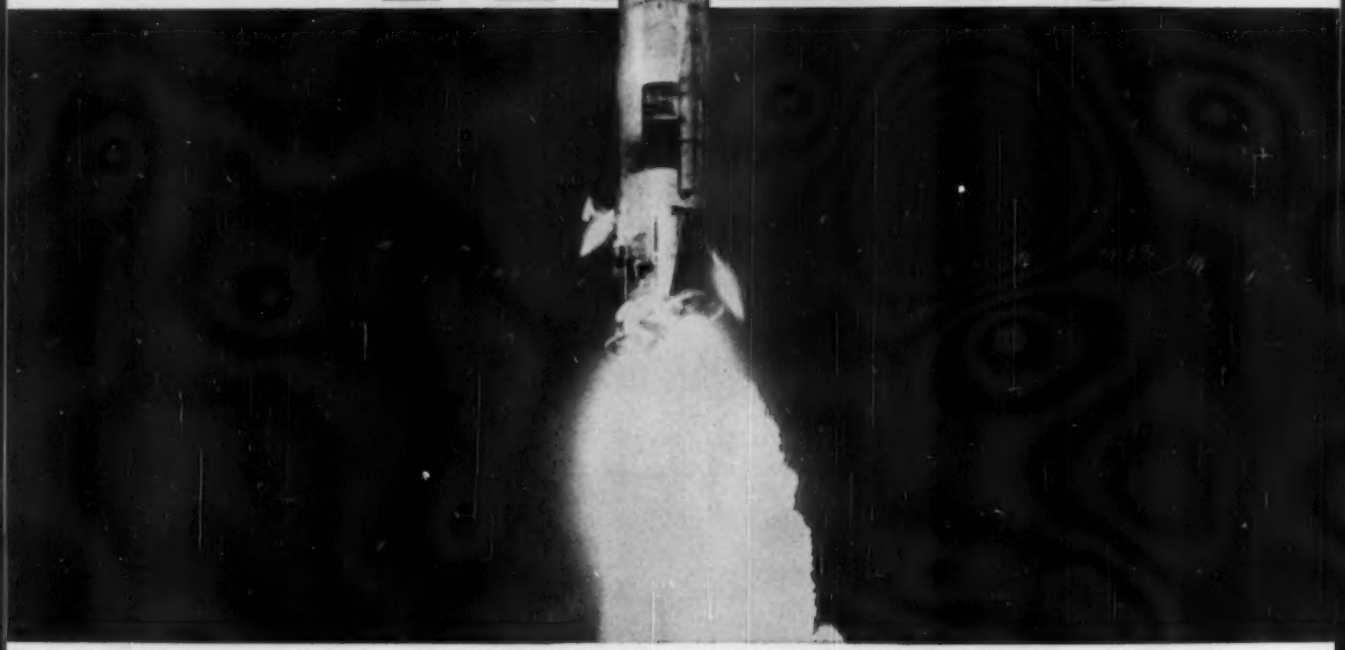
ATLAS

Air Force "Sunday Punch"



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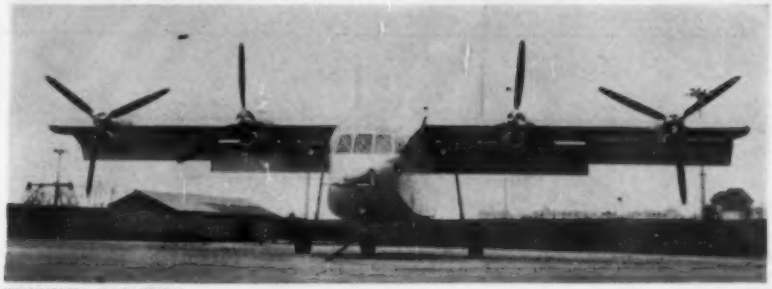

BREGUET 940 STOL

twin engine patrol aircraft under U.S. military aid. Martin aircraft will be based at Dakar.

Army's recent entry into aviation remains restricted to light aircraft and H-21 helicopters, all concentrated on meeting Algerian military needs. Recently the army placed an order for 150 Nord Aviation 3400 observation aircraft. This airplane flew for the first time early in 1958. The two-place aircraft is powered by a 260 hp. Potez inverted six cylinder engine. High lift wing permits low speed flight of 44 mph.

In the export field, the industry did fairly well with its known products. Sud Aviation during the year brought its backlog of firm Caravelle orders to 50 aircraft. George Hereil, Sud president, thinks there are 50 more orders to be picked up outside of the U.S. Initial Caravelle service will begin May 15 by SAS and Air France. Under a new agreement with Republic Aviation, Sud hopes to take another crack at the U.S. market.

This year Sud will turn out 20 Caravelles. Production rate by May, 1960, will be four per month. This figure will be carried to five a few months later. No major modifications are planned for the Caravelle in the years ahead, though company expects to improve performance with more powerful engines.

Sud's helicopter division continued to take a good share of the company's activity. At the beginning of this year 325 Alouettes had been delivered out of a series of 500 to be built. The five-place, turbine-powered helicopter has been sold to over a dozen military and civil users outside France. During the year Sud firmed its agreement with Republic Aviation under which the U.S. company will assemble and eventually manufacture Alouette in the U.S. Republic is also interested in Sud's new three-turbine helicopter which is due to fly this month. Sud 3200 is powered by three Turbomeca Turmo free-turbine engines producing about 400 shp. each. Gross military weight is 16,530 lb., gross civil weight is 15,650 lb. Service ceiling is just under 10,000 ft. and top speed is 130 kt.

Sud's third helicopter, its two-place Djinn, during the year won its U.S. airworthiness certificate. Sud had delivered 125 Djinns at the beginning of 1959, with another 50 on order. Both the Djinn and Alouette were used throughout 1958 by French forces in Algeria. U.S. Army and Navy also tested both helicopters during the year.

In addition to work on its three helicopter designs, Sud has begun assembling Sikorsky S-58s under license. The French military ordered 223 S-58s of which Sud eventually will build 150, both in H-34 and HSS versions. French order for 100 Vertol H-21s was completed during the year.

With the Vautour reaching the end of its production, Sud's remaining military aircraft activity centers on its Voltigeur. French Defense Ministry plans to order the aircraft in substantial quantity, and there are reports of U.S. Army interest. Informal talks have gone on between Sud and Beech Aircraft on U.S. license rights.

Voltigeur is powered by two Turbomeca Bastan turboprops developing

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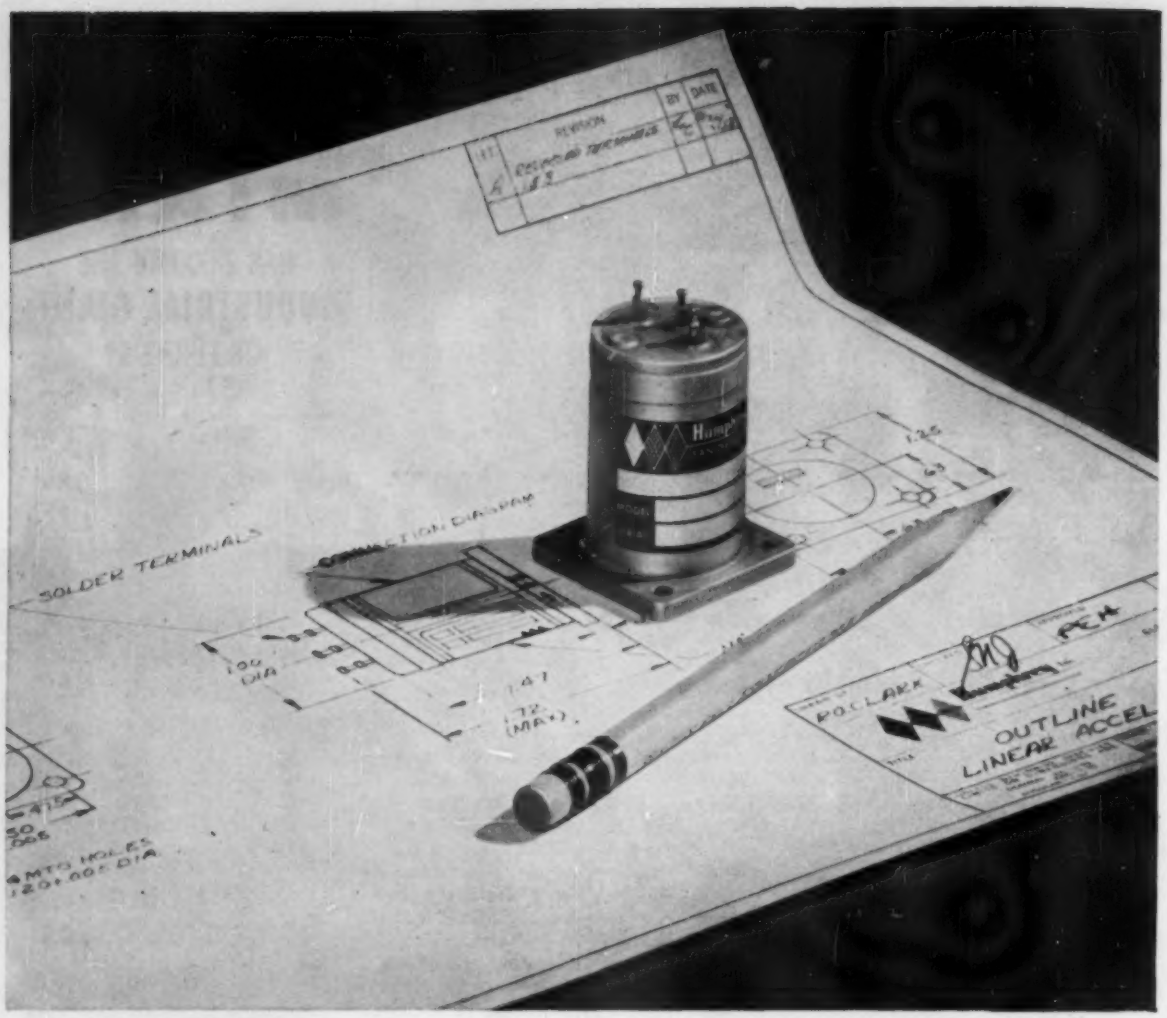

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MAX HOLSTE SUPER BROUSSARD

about 750 shp. each. Early this year the company lost the first prototype in accident which killed the three-man crew, including Roger Carpentier, a top French test pilot. Sud is also pushing a civil version of the Voltigeur, the Diplomate, which is pressurized and uses about 67% Voltigeur parts. There could be a bright production future for the Voltigeur as replacement for the several hundred Dassault MD-315 liaison aircraft still in use by the French military.

Snecma, the big State-owned engine company, is facing a drop in business. Up to now it has been busy supplying engines for the Noratlas, Vautour, Mystere and Super-Mystere, but now these production runs are ending. Company's latest production turbojet development, the Atar 8, and the afterburner version, the Atar 9, won't be produced in quantity. Atar 8 is to be used in Dessault's Etendard IVM, of which the navy will buy 50 when its finds the money. Atar 9 is to be used in the 100 Mirage IIIs ordered by the air force. Beyond these two projects there doesn't seem to be much business in the offing for Snecma.

Company's so-called Super-Atar, an all-steel engine designed for speeds in Mach 3 category and rated between 18,000 and 20,000 lb., has an uncertain future. Even if eventually used in Dassault's Mirage IV bomber (AW Feb. 9, p. 23), only a limited number of these aircraft will be built.

Actually, Snecma has had to finance development of its Super-Atar out of company funds.

Future of Snecma's Coleopter annular-wing, Flying Atar, is also under a cloud. During the year, unable to get sufficient development funds from the French Air Ministry, Snecma signed an agreement with German Defense Ministry under which German funds are being pumped into the program. Snecma is experiencing the usual difficulties with its VTOL project. As yet the company hasn't attempted conversion to horizontal flight with the Flying Atar, though it says it hopes shortly to begin free flights with its Coleopter, "during which the tilting to horizontal will be gradually carried out."

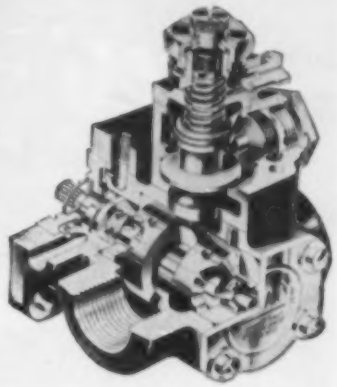
In contrast to Snecma's problems, the private French engine firm, Turbomeca, continues to enjoy fat order books and a promising future. Company already has produced over a thousand Marbore 880 lb. thrust turbojets, mainly for the Fouga Magister and Morane-Saulnier's five-place executive jet, the Paris, of which about 100 have been ordered by French and foreign buyers. Turbomeca's monthly Marbore production rate of 30 is being boosted to 70.

Next in order of importance for Turbomeca are its Artouste and Palouste gas turbine engines used, respectively, in Sud Aviation's Alouette and Djinn helicopters. Company's future helicopter business seems assured since its Turmo III free turbine engines will power Sud Aviation's new triple-turbine SE 3200.

Turbomeca expects a good deal of success with its new turboprop, the Bastan, which currently delivers 750 eshp. The Bastan already is scheduled to power several new prototypes. Besides Sud's Voltigeur, two Bastans will be used in Max Holste's Super-Broussard, a new French civil transport scheduled to fly early in 1959. The Super-Broussard will carry 17-20 passengers. Turbomeca also hopes to sell the Bastan as a retrofit engine for a Beech 18 twin-piston liaison aircraft.

During the year two Bastans were mounted on a Beechcraft in a test program jointly carried out in France by Beech engineers and an affiliate of Sud Aviation.

BILLION MILE CHAMP



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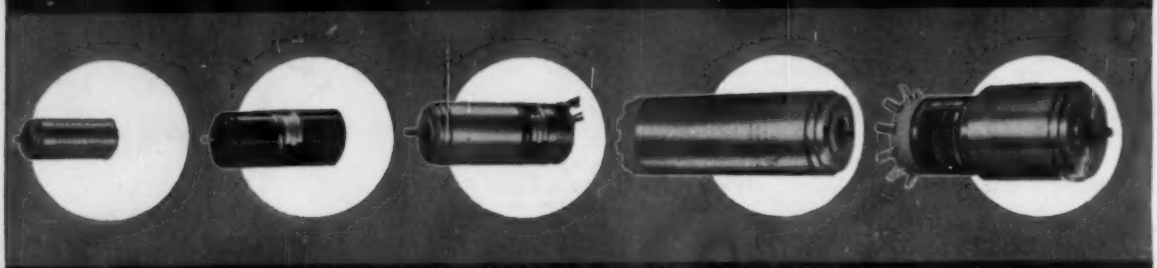

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8MTG-6201-01	8	1.850	2.3	0.77	26	40/20	6,500	2.2	0.16	26	0.25	0.5	15	± 5°
*10MTG-6228-02	10	2.157	4.2	0.72	115	115/57.5	9,500	2.8	0.26	115	0.45	1.5	19	±10°
10MTG-6229-12	10	2.100	2.9	1.09	33/16.5	52/26	9,500	3.0	0.28	26	0.45	1.5	13	±10°
*10MTG-6229-03	10	2.100	2.9	1.09	26	26	10,500	3.0	0.26	18	0.3	1.5	12	±10°
10MTG-6229-15	10	2.100	2.9	1.09	26	26	10,500	3.0	0.26	26	0.3	1.5	12	±10°
*10MTG-6232-05	10	2.104	4.2	1.1	115	36/18	6,500	3.5	0.26	115	0.30	1.5	15	±10°
11MTG-6251-13	11	2.531	7.0	1.3	115	115/57.5	6,500	3.5	0.63	115	0.55	0.5	19	±10°
11MTG-6251-00	11	2.531	7.0	1.1	115	40/20	6,500	3.5	0.63	115	0.55	1 5	19	±10°
11MTG-6254-01	11	2.200	6.0	1.1	115	115/57.5	6,500	3.5	0.63	115	0.55	1.5	19	±10°
15MTG-6280-01	15	3.281	14.0	5.3	115	115/57.5	5,000	6.2	1.5	115	3.0	0.2	13	± 5°
†*15MTG-6276-03	15	3.875	15.0	4.4	115	57.5	8,500	5.8	0.70	115	2.75	0.2	13	± 0.5°
18MTG-6302-02	18	3.680	20.0	5.7	115	115/57.5	9,000	16.0	2.7	115	3.0	0.2	13	± 5°
18MTG-6302-04	18	3.680	20.0	5.7	115	115/57.5	4,800	9.2	2.4	115	3.0	0.2	13	± 5°

*These units designed for 85°C ambient but same characteristics can be designed for 125°C. †Additional 21.4 watts for heater, the values given are independent of ambient temperature.

Other products include servos, synchros, resolvers, motor-gear-trains, AC drive motors, DC motors, servo mechanism assemblies, reference and tachometer generators, servo torque units, actuators and motor driven blower and fan assemblies.

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Circle Number 77 on Reader-Service Card

Canada's CF-105 Choice Shapes Future

Ottawa—Canada made a major decision last month that will shape the future of its aircraft industry and its defense forces: deciding not to go ahead with its home designed and built manned interceptor, the Avro CF-105 Arrow. The alternative is to rely on the Boeing Bomarc pilotless interceptor.

This key decision came just at the time Canada is observing the 50th anniversary of the first flight of an aircraft in the British Commonwealth made by J. A. D. McCurdy at Baddeck, Nova Scotia, Feb. 23, 1909.

Thirty-seven CF-105s are on order for the Royal Canadian Air Force, although the original RCA Astra navigation fire control system tailored for the airplane has been dropped (AW Nov. 10, p. 31). The 26 unbuilt planes are canceled. The twin-engine fighter is powered by Orenda Iroquois turbojet and estimates call for Mach 3 capability.

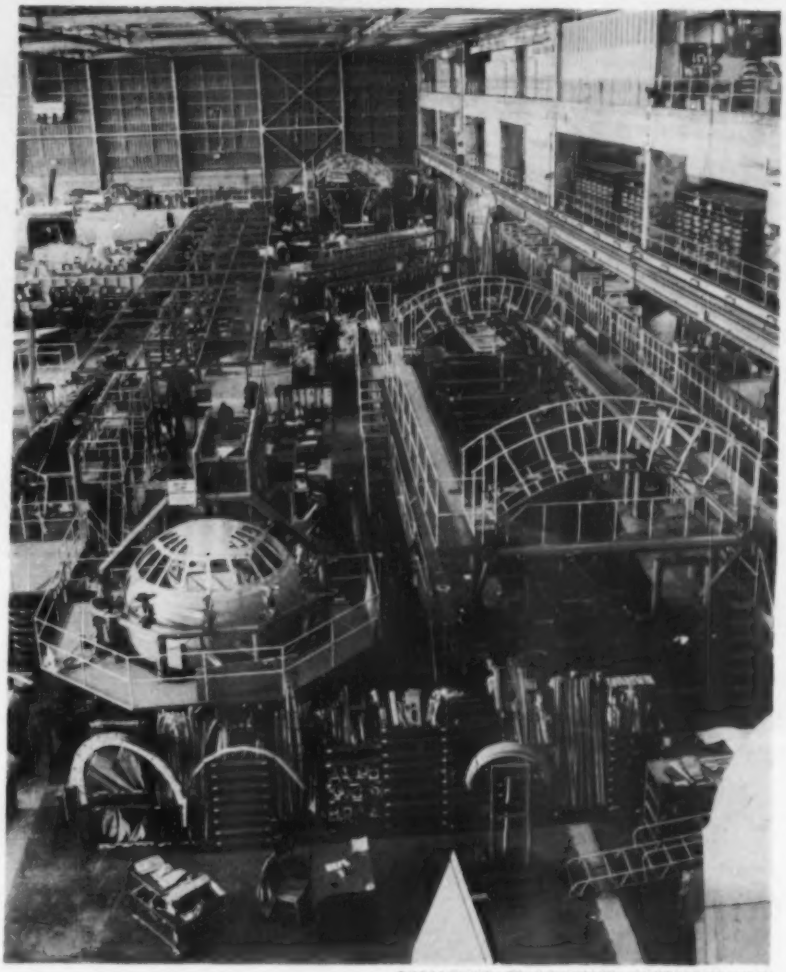
The government in recent months had intimated the cost of the Arrow is too high, that it cannot be integrated into the SAGE system, that North Atlantic Treaty Organization countries and the United States failed to order it although it is the fastest interceptor at present available to the western world, and that Canada will place its defense reliance on the Bomarc missiles and the U.S. Air Force.

Decision on the Arrow and the Orenda Iroquois will be important to A. V. Roe Canada Ltd., which owns both Avro Aircraft and Orenda Engines Ltd., at Toronto. The two firms employed about 13,000 people, and had built up the largest Canadian aeronautical design staff in the postwar period. Decision not to go ahead with the Arrow will mean the breaking up of the design team, although both companies will continue some operations.

Orenda Engines has formed a subsidiary company to service British diesel engines in Canada. Avro Aircraft has been at work for some years on a "flying saucer," first for the Canadian government and then for the United States government. This aircraft is expected to have peacetime uses as well and is one of the projects which will keep Avro Aircraft busy.

First flight of the flying saucer or flying jeep is expected soon.

Late in 1958 Avro Aircraft wheeled out the last of 600 CF-100 twin-jet interceptors for the RCAF and the Belgian air force. The CF-100 is in squadron use with the RCAF in Europe and



CANADAIR CL-44 FINAL ASSEMBLY LINE

AVRO CF-105 ARROW

Canada, powered with Orenda engines.

While the Avro organization and its suppliers await word from Ottawa, the other Toronto aircraft manufacturer, de Havilland Aircraft of Canada Ltd., is filling orders from all parts of the world for its single-engined Beaver and Otter transports, for the United States Army and the Canadian Army with its twin-engined Caribou transport which was first flown last summer, and with completion of an order for the Grumman CS2F-1 Tracker for the Royal Canadian Navy. De Havilland is the only one of the three major aircraft manufacturers in Canada which is not entirely reliant on military orders.

The third major Canadian aircraft manufacturer, Canadair Ltd., Montreal, subsidiary of General Dynamics Inc., is producing the CL-28 Argus coastal reconnaissance aircraft for the RCAF, a long-range transport version for the RCAF, the CL-44; the medium-range CL-66 transport, and a jet trainer, the CL-41.

The Argus and CL-44 are based on the British Bristol Britannia commercial transport, while the CL-66 is a turboprop version of the Convair 440. Canadair in 1958 finished production of the T-33 jet trainer and the last of 1,815 Sabre single-engined jet fighters for the RCAF, Royal Air Force, USAF, and various NATO countries. Canadair is to receive an order this year for components for the Bomarc missile, when Canada begins construction of Bomarc bases in northern parts of Ontario and Quebec. Sites for these bases were under survey early this year. Canadair is also expected to receive some orders this spring from the USAF as part of closer U. S.-Canada defense integration.

Canadian Pratt & Whitney Ltd., Montreal, is manufacturing a number of engines, including the R-2000 for the de Havilland Caribou, the R-1340 Wasp and the R-1820 for the de Havilland Otter and CS2F-1, Tracker.

Also at Montreal Rolls-Royce of Canada has this past year added 27,000 sq. ft. of floor space and a third test engine cell for overhaul of its Dart turboprop engines on British Vickers Viscount aircraft, and has arranged for servicing the Tyne and Conway engines to be used on Vickers Vanguard and Douglas DC-8 aircraft ordered by Trans-Canada Airlines.

Bristol Aeroplane Co., with plants at Montreal, Winnipeg and Vancouver, is largely engaged in overhaul of Proteus engines and others used on its Britannia.

Fairey Aviation Co. of Canada Ltd., maintains overhaul plants near Halifax on the east coast and at Vancouver on the west coast for servicing military and civilian aircraft, especially its naval aircraft used by the Royal Canadian Navy and the RCAF.

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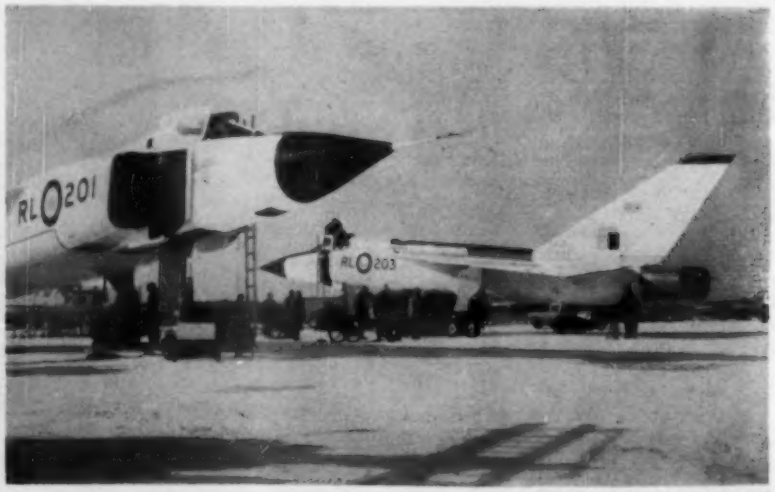
CANADAIR CL-66

DE HAVILLAND CARIBOU



AVRO CF-105 ARROWS

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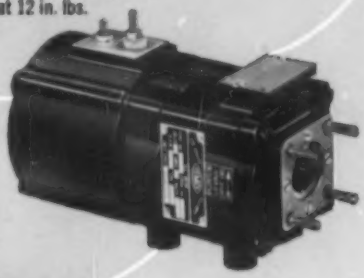
Type D-1082	4 HP	2 HP
Weight:	16 lbs. 3 oz.	16 lbs. 3 oz.
Motor Torque:	25 in. lbs.	12 in. lbs.
R.P.M.:	10,000	10,700 (approx.)
Terminal Voltage:	27 volts DC	27 volts DC
Operation:	In a period of 34 minutes: any 4 min. @ 25 in. lbs., balance at 12 in. lbs.	



Type D-1082-1	4 HP	2 HP
Weight:	13.87 lbs.	13.87 lbs.
Motor Torque:	25 in. lbs.	25 in. lbs.
R.P.M.:	10,000	11,500
Terminal Voltage:	27 volts DC	27 volts DC
Operation:	2 minutes max. @ 25 in. lbs. plus 10 min. max. @ 12 in. lbs.	

Type D-1029-1

Weight:	20 lbs.
Horsepower:	6 HP
R.P.M.:	7500
Terminal Voltage:	26.6 volts DC
Duty Cycle:	4.5 HP for 7.5 minutes 6.0 HP for 20 seconds 2.0 HP for 30 minutes

Single Phase AC Motor

Weight:	15 lbs.
Horsepower:	2 HP
R.P.M.:	10,000
Volts:	115 volts AC

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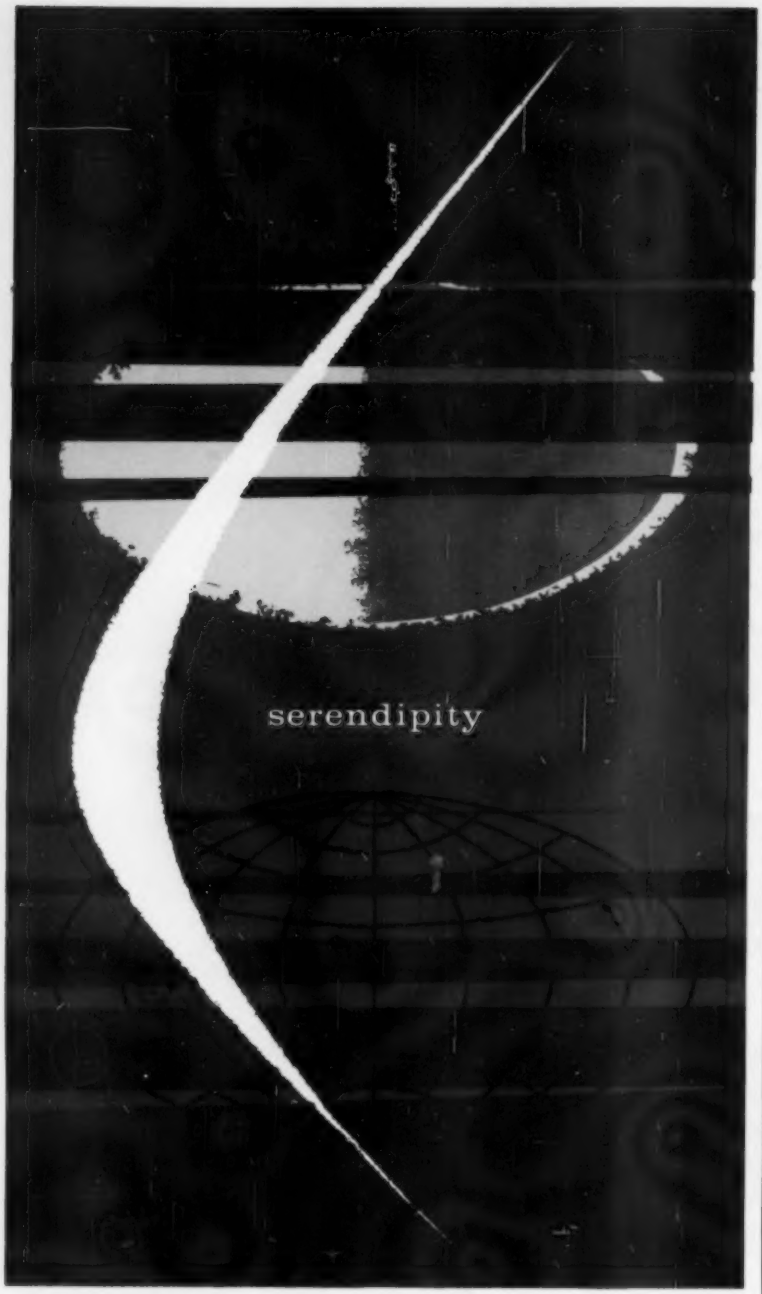

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MARTIN
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● CANADA

traffic and use of faster aircraft the Canadian government has begun construction of new terminals and enlarging airports right across Canada. Under construction at present are new terminals at Montreal, Toronto, Ottawa and Winnipeg, among major cities. Each is getting a different type of terminal, with Winnipeg and Toronto being the most unusual. Both will use a number of self-contained terminals where up to 10 aircraft can be loaded or unloaded at a time, contain car parking facilities, customs and immigration rooms, and all amenities, as well as heliports on top of each terminal building. New facilities are being built including the areas in the far north for polar route services.

An inventory of Canadian aviation must include the numerous aerial services in operation, including flight training through clubs and private companies, aerial survey operations from the international border to far above the Arctic Circle by private companies, aerial survey work by these Canadian companies throughout the world, and the vast use of helicopters for natural resources exploration. Okanagan Helicopters Ltd., operating in the far north and western Canada, uses Sikorsky S-55s and the French Alouette jet-powered helicopters. The company has also ordered British Fairey Rotodynes.

Spartan Air Services Ltd., Ottawa, is using Bell and Vertol helicopters, and along with Kenting Helicopters, Oshawa, Ont., is doing much aerial photography and survey work in Canada's Arctic and throughout South America and Asia. Photographic Survey Corp., Toronto, and Spartan Air Services are doing much high level aerial photography in the Canadian Arctic.

The RCAF, in addition to its military operations, is now flying its two de Havilland Comet jet transports across the Atlantic Ocean with full loads three times a month. The RCAF Air Transport Command is flying regular service with freight and personnel on a weekly basis to Pisa, Italy, for the Canadians with the United Nations Emergency Force in the Near East.

The RCAF operates an air division in Europe in France and West Germany, all squadrons being equipped with the Avro CF-100. Canadian domestic RCAF squadrons now have all been equipped with the CF-100. On the coastal command services the RCAF is replacing its Lancaster aircraft with U.S.-produced Neptune aircraft and the Canadair-built Argus.

Canada has stopped experimental production of missiles, but the RCAF has tested the Ryan Firebee. The Canadian government has announced that the Bomarc missile will be used in Canada, and work is to start soon on sites in northern Ontario and Quebec.

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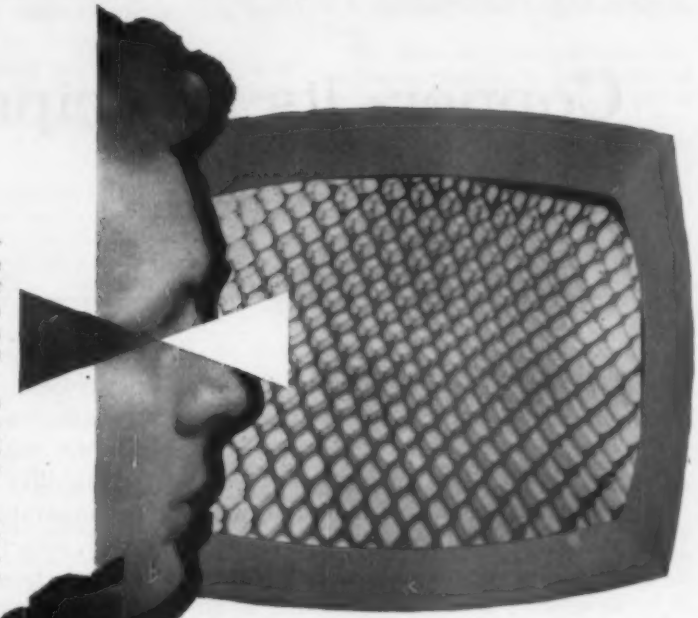

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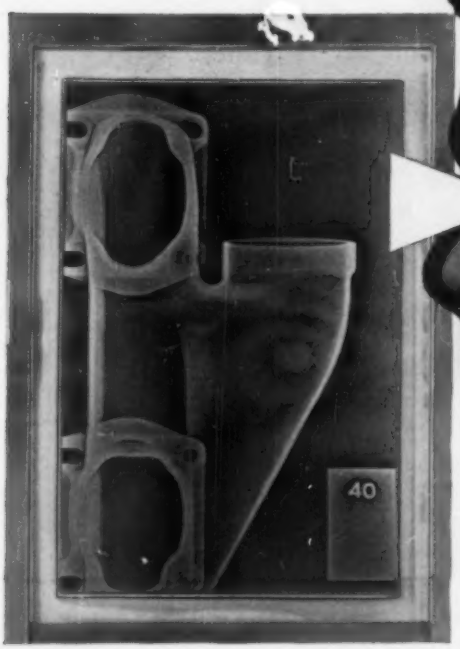
The system uses a conventional x-ray generator, and a monitor with a 12-in. picture tube (at right showing honeycomb weld) bright enough for viewing in normal room light. Any standard TV receiver will do as an additional monitor.



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● GERMANY

XVI

This is the sixteenth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Copper: Its Principal Effects in Alloy Steels

One of the best known of all metals, copper certainly needs no introduction here. Its uses are legion. It is one of the best conductors of heat and electricity. It is popular with the housewife, essential to the engineer. But possibly not so well known is its very important function as an alloying element in certain types of steels. So used, copper increases resistance to atmospheric corrosion and also acts as a strengthening agent.

Since copper does not oxidize in the steel melt, it can be added at any time during the course of the heat. Pure copper melts at about 1980 deg F.

Copper is added to steel in varying amounts. The actual proportion, of course, depends upon the end product in mind. Some of the most widely used copper-bearing steels are those containing from 0.20 to 0.50 pct. In these, copper has been found to increase corrosion-resistance without materially affecting mechanical properties. It has been found, too, that paint frequently lasts longer on such steels than on the non-copper-bearing types.

Among the best known of the copper-bearing steels are the high-strength, low-alloy grades developed in recent years. Generally speaking, the ductility of steels in this group is comparable to that of conventional structural steel. The yield strength, however, is usually higher. Copper, working as a team with chromium, nickel, and phosphorus, substantially raises the level of corrosion-resistance in these steels; yet its presence does not adversely affect welding characteristics.

Copper-bearing steels are a subject in themselves, a subject in which Bethlehem metallurgists are well versed. If you would care to know more about this interesting group of steels, feel free to consult with our technicians. They will gladly work closely with you and help with any problems you may encounter. And please remember, too, when you need alloy steels of any kind, that Bethlehem manufactures the full range of AISI standard alloy grades, as well as special-analysis steels and all carbon grades.

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BETHLEHEM STEEL

Circle Number 134 on Reader-Service Card

Germany Girds to Produce F-104, G.91

By Edith Walford

Bonn—German Luftwaffe is aiming towards a combined capability in interception, ground support and strike aircraft by the early 1960s.

First major step towards achieving this capability was the firm decision of the Defense Ministry to buy or produce under license about 300 Lockheed F-104 Starfighter interceptors and 200 Fiat G.91 lightweight strike fighters (AW Dec. 8, 1958, p. 28).

This decision was taken after delays and postponements over a period of nearly two years while German experts were flight testing and evaluating 14 contestants for the big order: three British, one Swedish, two French and eight American aircraft.

F-104 Production

Original proposal by the West German Defense Ministry was to buy only a handful of Starfighters outright. The rest were to be manufactured under license in Germany.

One of these deals has been the subject of hard bargaining now for several months between Lockheed Aircraft Corp., General Electric Co., manufacturer of the Starfighter's J79 engine, and the German Federal Republic's Defense Ministry, which is the actual license holder. These negotiations came to a sudden head early in February when the Defense Ministry placed an order for 96 F-104s and signed license agreements for construction of the remaining machines by the German aircraft industry.

Announcing the decision to buy 300 Starfighters at a total cost of about $357-million, German Defense Minister Strauss said that the interceptor was "the best in the world."

Average price of those delivered from Lockheed to Germany will be $1,450,000 each. Cost of the German-built series will probably be higher than standard because specially-developed electronic equipment will be installed at a cost of about $325,000 per aircraft.

Order Increase

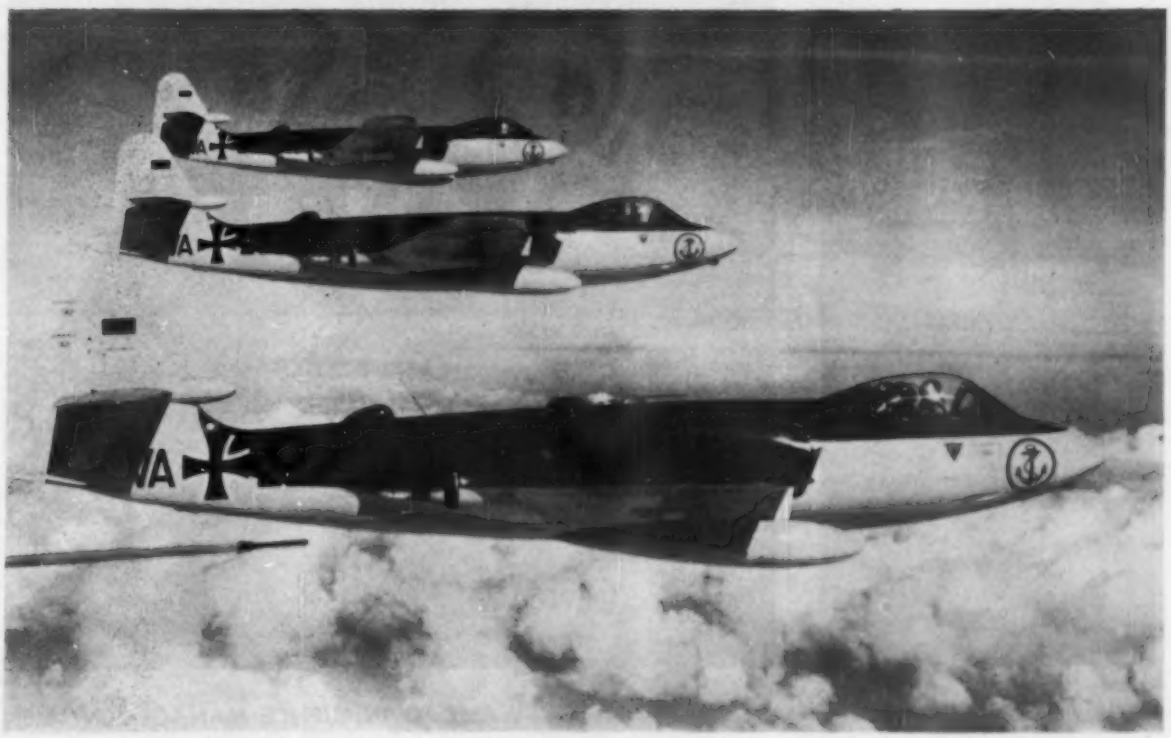
The increase in the original number of aircraft to be bought fully equipped is an indication that the Germans are taking a more realistic view of their own present production capabilities which cannot be stepped up appreciably in the immediate future.

The order comprises six development aircraft, which will probably be delivered first; 30 two-seat trainers; and 60 with standard airframe-engine-configuration.

The German Defense Ministry was continuing negotiations with Lockheed on cost, delivery dates, etc., as well as with General Electric for the production under license of the J79 turbojet engine. These will probably be made by Bayerische Motorenwerke (BMW) as the chief contractor, the German automotive industry sharing in the component work. The engine contract is expected to be signed by mid-March. Depending on the time required by the Germans to get the J79 into license production, the final number purchased could be between 200 and 300.

Following final signing of this contract, the German Defense Ministry is expected to open talks with Fiat S.p.A. of Turin, Italy, on the purchase of 50 and production under license of another 150 G.91 lightweight strike fighters. The German Defense Ministry announced its intention to equip the Luftwaffe with 200 of this type simultaneously with the announcement of its F-104 Starfighter choice last November (AW Nov. 10, p. 33).

The German aircraft industry is now faced with its most difficult task since its postwar resurrection. It lost 12 valuable years of research and develop-



GERMAN insignia mark Armstrong Whitworth Sea Hawks ordered for the German navy.

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ment work during the postwar prohibition to rebuild any of its strategic industries. It has had time enough to realize that it must look to the license production of leading foreign aircraft like the Starfighter and G.91 on which to base its rebirth.

But even with these three long-hoped-for orders practically in its pocket, it looks like several months yet before work can start in earnest.

The German Defense Ministry's requirement calls for delivery of the first German-produced Starfighters by the end of next year or the beginning of 1961 at latest. If, as some German sources claim, the Defense Ministry calculates with a production rate of only five to eight planes a month, this brings delivery of the final machines into the mid-1960s.

Opinions are that this rate of production is too slow, that it will take the German aircraft industry more time than it can now afford to set up adequate production facilities, let alone find the skilled labor to control them. So far the companies concerned have done only a limited amount of preliminary planning for the big job ahead.

Present Employment

Present employment of the entire German aircraft industry is about 10,000 people in all grades of skills. This is equivalent to about one-sixth the number employed by Lockheed alone. Of the 10,000 fewer than half are available in the companies traditionally concerned with fighter aircraft production in the south of Germany. Here, individual employment is about 1,000 per company.

Production of the F-104s and G.91s will probably be turned over to the three chief aircraft companies in Southern Germany: Dornier-Werke GmbH, Munich-Neuaubing; Ernst Heinkel Fahrzeugbau GmbH, Speyer a/Rhein; and Messerschmitt A.G., Munich. The latter has a new assembly area now under construction and scheduled for completion next year. It will serve as a replacement for the two separated assembly areas at present in use. In addition, all three companies have lately been working on preliminary layouts for factory floors and trying to estimate their material requirements for the immediate future at least. But that is as far as their preparedness for the tough task now confronting them can go.

It remains the opinion of many German experts that the license production in Germany of the F-104, the G.91, or for that matter of any other modern aircraft will swell its cost to a figure far in excess of the price asked for such aircraft purchased fully equipped from abroad.

Developments during the next few

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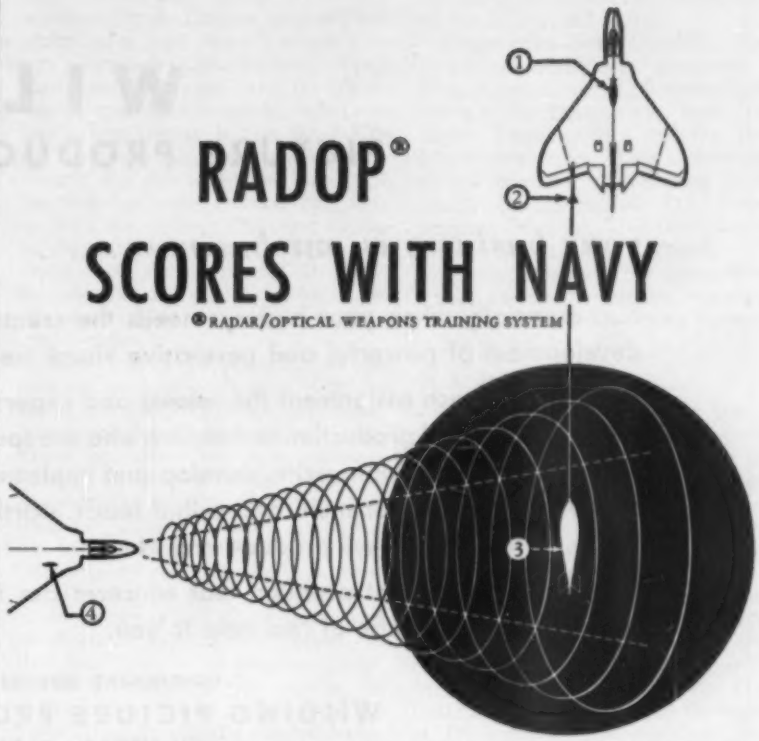

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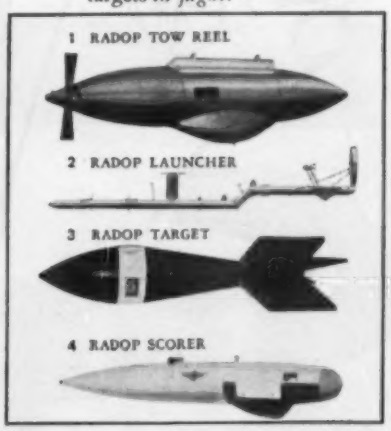

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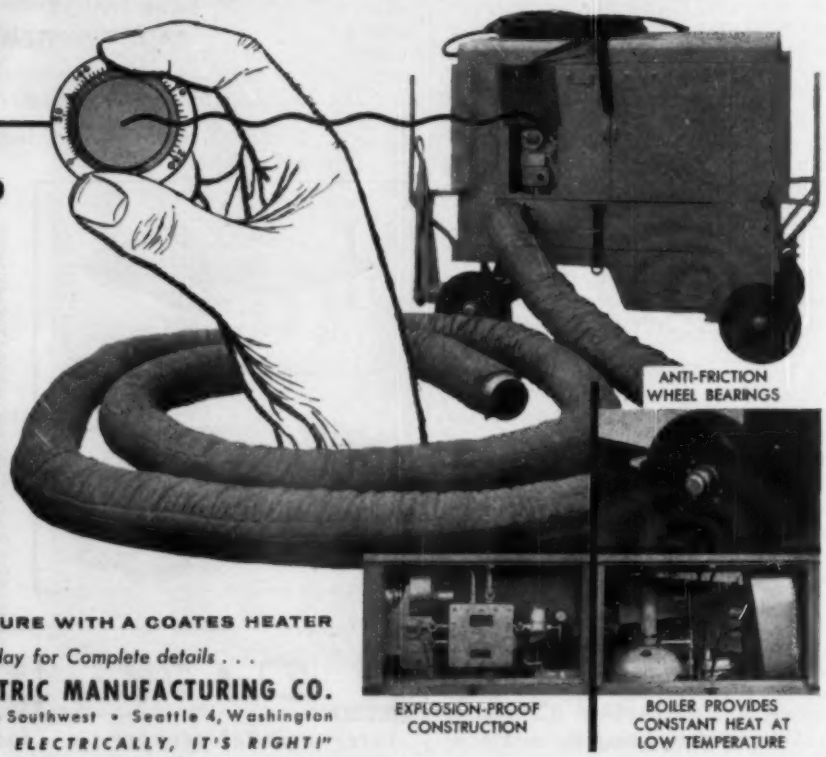

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months should be of decisive significance to the future of the German aircraft industry as a whole. The solution of the present production problem looks like a precedent and a pointer to the road the German aircraft industry must take from now on out. The question is whether it is more profitable for the German or any other European aircraft industry in the future to produce its own modern aircraft or to purchase them abroad.

Flugzeug-Union-Süd G.m.b.H., Munich, was formed in 1956 to coordinate production facilities of its two member firms: Messerschmitt and Heinkel. Its first postwar assignment was the manufacture under license of 210 French-designed Fouga Magister trainers for the Luftwaffe (AW March 3, 1958, p. 291). Production of this series has currently reached a rate of six a month, but only about 50 of the whole series have so far been completed.

Towards the end of last year, Bölkow-Entwicklungen K.G., until then at Stuttgart but recently moved to Munich, joined the Flugzeug-Union-Süd group to cooperate in "preparing for the bigger tasks of the future." This design team is at present working on the development of high performance manned and unmanned aircraft. Other current studies of the group include a vertical takeoff and landing interceptor as a next generation supersonic fighter for the Luftwaffe.

Team Formation

Following the same pattern a new design and development group called "Arbeitsgemeinschaft G.m.b.H." (Working Team) has been set up to cooperate on the Defense Ministry orders for the Starfighters and G.91s. The German-produced planes are to be renamed Arge-104 and Arge-91. Member companies of the new group are again Messerschmitt and Heinkel in addition to Dornier-Werke G.m.b.H.

Messerschmitt and Heinkel expect to produce the F-104's jointly while Dornier is likely to get the G.91 order.

It will take Dornier approximately one more year to finish current production orders for its Do.27 six-seater STOL plane, which was the first and only postwar German aircraft to be ordered in large quantity by the German Defense Ministry. The Messerschmitt-Heinkel produced Fouga Magisters will not complete their production runs for another two years. Consequently, Dornier will need new work long before the other two manufacturers are ready to carry out simultaneous production of the G.91 and F-104.

The Heinkel and Messerschmitt plants are only on the order of a quarter-million square feet each. The Dornier works is the largest and best equipped of the three. Moreover, the only available long runway in Germany is adjacent to the Dornier plant at Oberpfaffenhofen near Munich where Dornier overhauls Canadair-built North American Sabre 5s and 6s for the USAF. But not even the Oberpfaffenhofen runway is long enough to take the F-104s in anything but ideal weather conditions. For this reason the industry is awaiting Luftwaffe decision on where to build the military flight-test station to determine where to build its own runway required in future. It is felt that this decision should determine the choice of which firm gets the final assembly order.

Apart from all this planning and preliminary work in connection with the Starfighter and G.91 license production orders, leading German aircraft companies are either continuing maintenance or overhaul of foreign aircraft or concentrating on the development of their own designs. Heinkel is carrying out maintenance and repair work on Cessna L-19A planes for the U. S. Army and Dornier, in addition to overhaul of the Sabre 5s and 6s, is continuing its efforts to develop new markets for the Do.27 army cooperation plane. CASA of Madrid is now making 50 of these under license in Spain and the Swiss Flugwaffe recently ordered seven.

It seems probable that the Siebelwerke-ATG, Donauwörth, which belongs to the big German, Flick-controlled, industrial concern similar to Krupp, will soon be asked to join the Arbeitsgemeinschaft G.m.b.H. along with Heinkel, Messerschmitt and Dornier. The German Defense Ministry is reported to be interested in acquiring some of the Siebelwerke stock as the first move in paving the way to the question of whether and to what extent Siebelwerke would be inclined to cooperate in the production under license of the F-104s and G.91s.

Flugzeugbau Nord G.m.b.H., Hamburg-Finkenwerder, is composed of Flugzeugbau G.m.b.H., Bremen; Siebelwerke-ATG, Donauwörth; and Hamburger Flugzeugbau G.m.b.H., Hamburg-Finkenwerder. This Construction Group North is still sharing in the license production of 112 French-designed Noratlas 2501 twin-boomed transports for the Luftwaffe. The contract, from which the group derives a good share of its earnings, was signed in 1956 with Nord Aviation, Paris, and is due to expire in 1966.

U. S. Interest

United Aircraft Corp. last year acquired 43% of the Krupp-controlled "Weser" Flugzeugbau stock. First step in the new agreement with the American firm calls for the production under license by Weser of Sikorsky helicopters. Whether this will result in the German company having to discontinue its current assembly of Vertol H-21 helicopters has not yet been decided. Weser is also carrying out de-cocooning work on the U. S.-built Republic F- and RF-84Fs. President of Weser, Dr. Peter Burkhard, recently increased the capital of his company from four to seven million D-marks. United Aircraft Corp. has taken over the extra three million.

Prototype of the Borgward Kolibri three-seat helicopter, Germany's first postwar rotary wing aircraft designed by Professor Heinrich Focke and built by the automobile firm of Carl Borgward, Bremen, is at present being flight tested. As soon as these trials are concluded, the firm plans a first production of ten of these single-rotor helicopters. Power-plant is a Lycoming VO-435A1A piston engine.

GERMANS will build the Fiat G.91 under license.

● ITALY

Flying Italian Designed Aircraft Lifts Morale of Italy's Pilots

By David A. Anderton

Rome—First squadron of Fiat G.91 lightweight strike fighters is now being activated as an operational unit with the Italian air force.

For the first time since the war, Italian pilots are flying Italian-built and Italian-designed combat planes. By the end of this year, a major portion of the air force's interceptor squadrons should be equipped with Italian-built aircraft, North American F-86Ks built under license by Fiat. By this time next year, Italian student pilots may be learning to fly in an all-jet curriculum starting with an Italian primary trainer, the Macchi MB.326.

This resurgence in Italian military aviation has not come easily, nor has it been made alone. The road back from the political and tactical disasters of World War II has been a hard one. Italian military pride, cut deeply by the tragic-comic turn of Italy's contribution during the war, is still healing.

That pride, worn almost as a badge of office by many of the military, is one of the major intangible reasons for the growing strength of Italian air power today.

The tangible reasons are the American-designed fighting airplanes—North American Sabres and Republic Thunderstreaks given outright to the Italians—backed up by aid programs that have helped set the country on its feet again.

Bulk of Italian air force equipment is made up of four American types:

- North American F-86E Sabre day fighters, built by Canadair under license as the Sabre Mk. IV.
- North American F-86K all-weather fighters, built under license by Fiat and corresponding to the F-86D in USAF service except for different fire-control system and armament.
- Republic F-84F Thunderstreak fighter-bombers.
- Republic RF-84F Thunderflash reconnaisance aircraft.

This roster should change in proportion somewhat during the coming year. As Fiat G.91 squadrons are phased in, they will replace Republic F-84F units. This decision can be debated on cold technical grounds because there is essentially no performance improvement in the G.91 over the F-84F, except in economy of operation and short-field performance. The ability of the G.91 to operate out of forward unprepared airstrips is one of its strongest points, and yet current fighter-bomber squadrons are stationed on permanent bases about as far forward as it is possible to get in Italy.

But there is no arguing with the morale boost when Italians fly Italian planes.

Top air force officers realize that day fighters can be completely useless in modern warfare, and want to start replacing the F-86Es with F-86Ks. This decision depends on what money will be available.

Air force also wants to reduce the number of training types now being used from the current level of eight to possibly three. It would like to make the first-stage trainer the Macchi MB.326, and plans are under way now to order about 70 of these planes. But again, money is the key to the situation.

The Aeronautica Militare Italiano (AMI) is both a tactical strike and air defense force with a triple mission: home air defense, ground support and naval support.

Part of AMI works under the operational command of Airsouth, the air arm of the southern flank of NATO, in conjunction with elements of the Greek and Turkish air forces.

The larger part is under six Italian zone commanders, four on the peninsula and one each on Sicily and Sardinia.

Any consideration of Italian air power has to relate it to its two primary jobs: first, its home defense mission, and second, its contribution to NATO as part of the "shield" forces of the southern flank.

Italy extends as a 750-mi. long link in the NATO defense chain, stretching roughly parallel to the frontiers of Bulgaria, Roumania, Hungary and Czechoslovakia, and less than 400 mi.—40 min. flying time—away. A fifth Communist country, Albania, is separated from the heel of the Italian boot by less than 100 mi. of open water at the southern extremity of the Adriatic sea.

Strategically, Italy is a most important component of the NATO system. Together with Greece and Turkey, she holds the southern exposure of the European defense scheme.

Tactically, Italy has its own defense problem. Italian industry is concentrated mostly in the northern plains made productive by the Po river.

The major threat facing Italy is the

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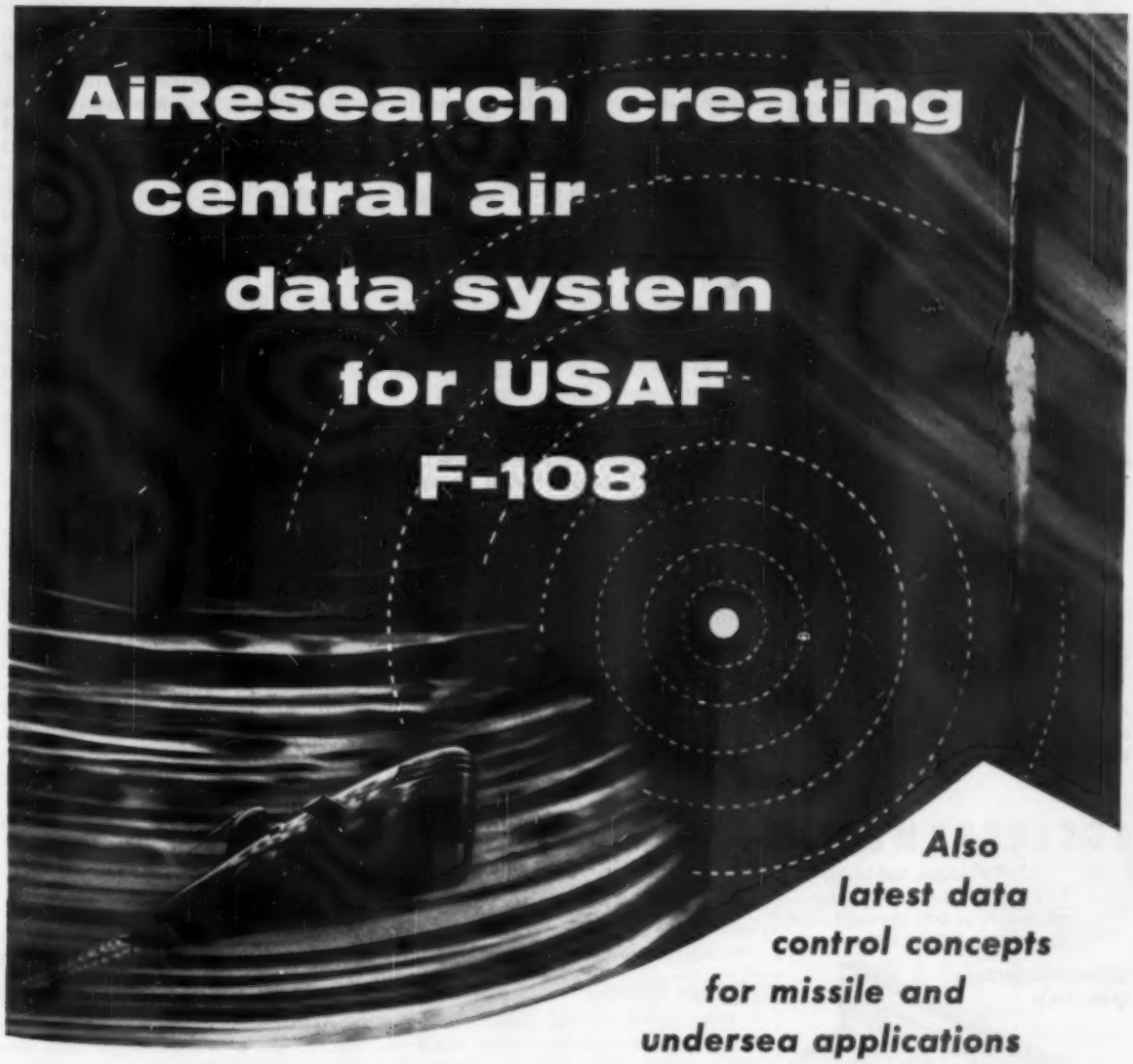

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same threat that faces all the NATO countries: a low-level strike against tactical and industrial targets by light or medium bombers operating in the radar shadows. The chances of this being an isolated strike are remote; the general assumption of NATO is that any individual strike would be part of a general Communist attack on a broad front from the farthest north to the farthest south.

Closest Communist strike force which could be flung against the Italian peninsula would probably be tactical bomber squadrons based in Hungary, moved in on short notice to augment the internal security units which now comprise most of that country's air strength.

The bombers would slash across the 120 mi. separating Hungary and Italy, roaring low over the mountains on the Austrian-Yugoslavian border to strike into the industrial north.

The situation is complicated by the presence of Austria and Yugoslavia between Italy and the enemy. What would or could these countries do?

The answer for the Austrians is simple: nothing.

It's different for the Yugoslavians, who don't particularly like the Russians and could be expected to attempt interception if their country were being overflown. But not much of the country would be violated in such a strike, and the flight time might be so short as to catch the Yugoslavian air arm on the ground.

The probable answer and the governing assumption for war plans is that Italy would get little or no help from the buffer area, either in time, warning or intervention.

Italian Forces

Opposition to the strike would be the fighter-interceptor forces based in Italy either as part of the Italian air force or as part of NATO's Fifth Allied Tactical Air Force (FIVEATAF) headquartered in Vicenza.

Primary defensive strength would lie in the Italian air force components, because FIVEATAF is almost completely a tactical fighter-bomber force for retaliation.

Units taking the brunt of the attack would be the Primo Aerobrigata and the Primo Stormo, both equipped with all-weather Fiat-built North-American F-86Ks. Primo Stormo is attached to 5th ATAF as its only Italian fighter-interceptor group.

If the weather was good, day fighters of the Quarta Areobrigata and Secondo Stormo—Canadair-built North American F-86Es (Sabre Mk.IV)—would also be thrown into the fight.

Italian air brigades are roughly equivalent to a USAF wing of 75 aircraft. With the current squadron availability of the Italian air force standing at the high figure of 75%, about 225 fighter-interceptors could be flung into action against the attack. In bad weather, the number would be halved.

Estimates of Communist fighters available vary, but average out at about 1,200 day and all-weather fighters aligned against the southern flank. Giving the satellites only a 50% availability, which may be underrating them, results in a fighter escort or counterair force of 600 planes, or about three times the Italian fighter strength.

This is why briefing officers mention the obvious fact that the Italian air force—and for that matter the entire southern air arm of NATO—is outnumbered. This is also why one of the obvious solutions for Italian peninsular defense is a long line of missile batteries.

Currently about 200 Italian airmen have been trained at the U.S. Army Guided Missile School at Ft. Bliss, Tex., working with the Nike Ajax, Nike Hercules and Hawk anti-aircraft missile systems. These men will be the nucleus of the Italian defensive missile arm.

Missile bases for either Douglas Thor or Chrysler Jupiter IRBMs have been tentatively chosen. But the politics—both internal and international—of IRBM bases have overshadowed the strategic and technical considerations of the immediate problem, and progress is slow.

It is believed that only a decision in principle has been taken to move IRBMs into the Italian peninsula.

Pilots and Airmen

Any air force is only as good as its pilots—or its airplanes or its logistics or any other major part of the system. How good is the Italian air force?

Rated absolutely, it shows deficiencies. It is understrength and also outnumbered. There is a pilot shortage and a shortage of air control and warning personnel.

Full radar coverage is lacking, and there are operational and maintenance deficiencies.

The aircraft are not the latest generation, and some of them are frankly castoffs.

But what Italian airmen and pilots have done with what they have is nothing short of amazing.

American observers, either military or technical, are struck by the individual flying ability of the Italian pilots, by the ingenuity and skill of the mechanics, by the drive of operations personnel. They cite the outstanding Italian acrobatic teams—1958 NATO champions—as examples of discipline in the air and superb airmanship. They point to the extremely high availability record of AMI fighters: 75% or better, going or ready to go at any time. This record is maintained by considerably lower

numbers of ground personnel per squadron than in the USAF.

So rated relatively, the Aeronautica Militare Italiano ranks high on the list. Individual and unit moral is excellent. Cooperation with NATO and USAF advisers is free at all levels. Plans for the future growth have been made and are being carried out within the limits imposed by the country's economy.

The problems are great; but the progress made is greater.

Politics Bogs Japan's Choice of New Self-Defense Force Fighter

Tokyo—Postwar Japan's rejuvenation of its aircraft industry last year was confronted with major headaches. Its problems included:

• **Selection of fighters** for Japan's Self Defense Agency air force ended in frustration. There is no prospect of getting any one of the candidate aircraft selected in the near future. This means Japanese aircraft manufacturers will have idle plants and will lose some of their experienced technicians because more than half its work orders come from the Self Defense Agency.

• **U.S. mutual security** aid to Japan shrunk to less than half the $221 million paid in 1954, the year the agreement was made. Last year Japan received $111 million to build 169 F-86F and T-33A aircraft.

• **Major production plans** for 1959, as a result, have been limited to F-86Fs by Mitsubishi Heavy Industries, Reorganized, and P2V-7s by Kawasaki Aircraft Mfg. Co.

Political squabling torpedoed plans of Japan to build the Grumman F11F-1F to re-equip its air force and left the situation in doubt for any airplane. Japan also was considering the Lockheed F-104 as well as others, including the North American F-100, the Convair F-102 and the Northrop N-156.

The issue became embroiled in the constant struggle by conservatives to beef up Japan's defenses and the socialists to trim them. Prime Minister Nobusuke Kishi, through a series of political miscalculations, now is in no position to push anything through parliament against strong opposition.

Thus observers in Japan see little chance of any choice of any kind being made before mid-year.

A hands-off policy by the U.S. military in not siding with one airplane or another has contributed to vacillation on the part of the Japanese.

Since the reopening of aircraft building in 1952, Japan has built 650 planes of its own at a cost of $106 million, as of the end of 1958.

Of this total, 220 aircraft—more than one-third in the numbers of units or more than 40% of expenditures—were built last year.

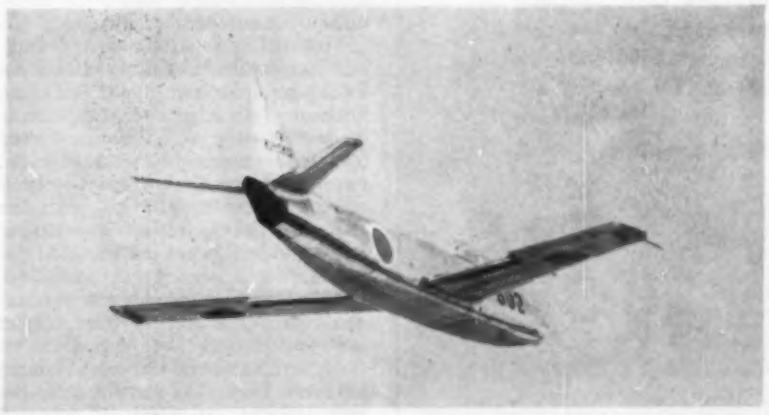
Industry Strength

There are 25 Japanese aircraft companies with a total of 21,000 employes and total capitalization of $35 million. None of these companies are independent, including Mitsubishi Heavy Industries, Reorganized, and Kawasaki Aircraft Company.

These companies are either part of, or subsidiary to parent companies, a fact which is helping them to withstand the imminent drop this year.

Under the circumstances, no expansion program was undertaken last year by any of the firms. Proportions of work orders the industry received last year were 56% from the Self Defense Agency, 37% from USAF, 6% from civil airlines and 1% for exports.

Japanese manufacturers, however, are likely to stick together, especially when



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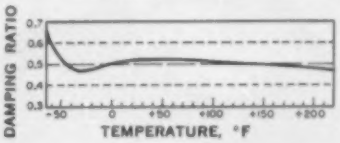

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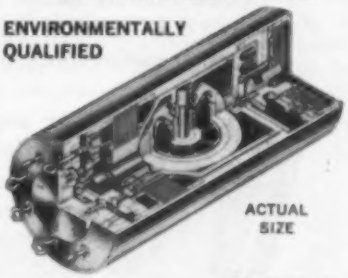

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• JAPAN

production is expected to slow down. For instance, the manufacture of the YS-11 turboprop transport plane has been a going concern of the industry since 1955. Late last year, the transport plane designing association completed a mockup of the YS-11. Early this year, a new company was established with a capitalization of $1.4 million as a joint venture of major Japanese aircraft companies. The government has 60% capital investment.

For Fiscal 1959, the Ministry of International Trade and Industry is subsidizing the newly established company with $170,000 to work out the details of the mockup of the airplane.

Another joint venture of the sort is the manufacture of the T1F2 jet trainer designed and built by Fuji Heavy Industries, Ltd. with its J3 engine manufactured by Ishikawajima Heavy Industries, Ltd. With testing under way since last spring, the Self Defense Agency has ordered 20 T1F2 jet trainers from Fuji for this year in preference to the Beech T-34 Mentor piston trainer. Fuji is also the manufacturer in Japan of the Mentor, which is being produced in quantities of four units a month for a total of 36 for the Philippines as reparation items.

The Self-Defense Agency has built the air force starting from scratch in 1952 to 861 planes, including 283 F-86Fs and 223 T-33As last year.

As of midnight April 28 last year, the Japanese air force ordered its air squadron in Hokkaido, the northermost island of Japan, to take over "scramble" duty from the USAF stationed in Chitose, Hokkaido.

This is an indication that the Japanese air force is beginning to feel responsible for home air defense. The Self-Defense Agency also took over 13 of the 24 U.S. radar networks in Japan last year by allocating $1.8-million for the maintenance.

In the missile field, the Self Defense Agency fired its first guided missile—the B-3—with a built-in TV transmission set last summer.

To make up lost time in developing missiles, Japan bought a $1 million Swiss ground-to-air guided missile—Oerlikon—with a launcher and 10 rockets last summer. Self Defense Agency technicians thoroughly went over the missile last year, but it has not been fired yet for testing. This year, the Defense agency is expecting assistance and use of facilities of the USAF to test fire it.

The Self Defense Agency also ordered 14 Sidewinder air-to-air missiles last year through the Japan-U.S. security agreement and will order 90 more for Fiscal 1959. The first shipment has been delayed. It won't be delivered until late this year.

SAAB J-35A with lengthened fuselage and a retractable tail wheel added aft, is shown ready for its first flight.

Sweden Adds Missiles to Air Inventory

Stockholm—Sweden's purchase of American Sidewinder air-to-air missiles as primary armament for Royal Swedish Air Force fighter unit underscores that force's current orderly transition to the missile age.

Sidewinders will augment the striking power of three RSAF fighter aircraft: Saab J-35 Draken, Saab J-32B Lansen and the purchased Hawker Hunters (J-34). Increased strength of the weapon systems thus formed will be one basis for planned reduction of the current RSAF roster by two day-fighter wings over the next few years.

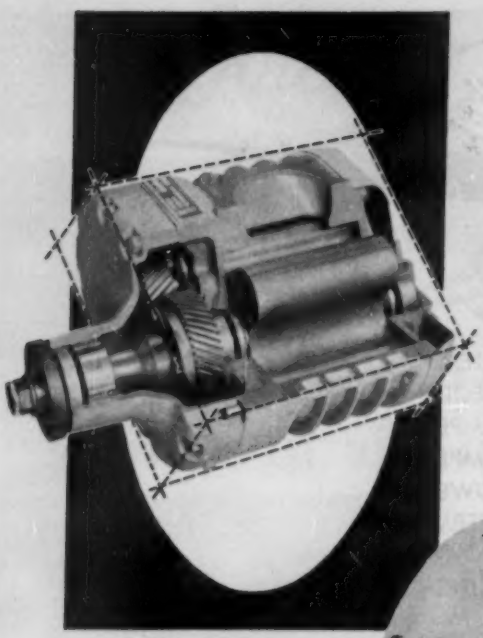
Parallel to this transition to missile armament, Swedish scientists on the air board have development programs well under way for a series of specialized missiles. First of these for the Air Force is an air-to-surface missile—basically resembling a scaled-down Bell Rascal—to be carried by attack versions of the Saab Lansen.

Bristol Bloodhound anti-aircraft missiles have been ordered by the Swedish government for initial training and familiarization with the problems of operating such types of surface-to-air missiles. Future purchases of similar systems will be based on the experience of the next few years with the Bloodhound.

This planned transition to the requirements of nuclear and robot warfare had its roots in a staff study completed in the closing months of 1957, approved last year, and now being implemented. Basic decision taken was to reduce the number of manned aircraft now on the roster to about three-quarters of its present value. Part of this reduction rose out of the recognition that the day fighter has a lessened importance in modern aerial warfare, and that altitudes, speeds and weather conspire to make manned visual control of weapon systems a matter of doubtful value.

This staff study hammered home the enormous significance of unmanned weapons, nuclear warheads, and weapon

SUPERSONIC SAAB J-35 Draken's armament will be augmented by use of Sidewinder infrared guided missiles purchased in the United States. Two of the four missiles, which were developed by the U. S. Navy, are mounted under the airplane on a pylon shaped like an inverted letter Y. The missile chosen is the new model with a shorter, more compact configuration (above). Area at the base of the seeker head is slightly increased and the fin area at the motor aft has been substantially increased.



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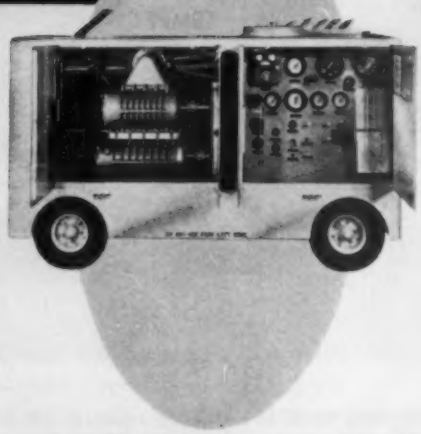

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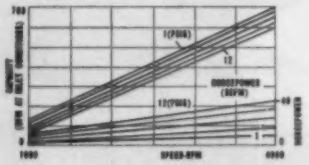

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Coming less than a decade after another major staff study—which had decided to increase the Air Force strength by about half—this study called in part for a brisk 180 deg. turn. Right now the Royal Swedish Air Force is in the middle of that turn.

Phasing in now after rugged winter and operational testing is Sweden's airborne pride, the supersonic Saab J-35 Draken. The achievement of the relatively small but brilliantly staffed Swedish aircraft industry in turning out—in a time cycle comparable to the fastest—a modern Mach 2 weapon system has surprised technical observers the world over. The double-delta Draken is now being delivered as a production aircraft equipped with full afterburning for its Swedish-built Rolls-Royce Avon 200 series turbojet. Peak performance of the plane is somewhere over the Mach 2 mark, perhaps on the order of Mach 2.3. Combining the altitude and speed potential of this launching aircraft with a fire control system and the slamming strikes of a pair of Sidewinders has produced a formidable weapon that the Swedes feel could take on any enemy threat and overcome it.

Today the Royal Swedish Air Force numbers approximately 20 wings. Nine of these, or 27 squadrons, are day-fighter units, mostly equipped with the Saab J-29 Flying Barrel. Two day-fighter wings protecting Stockholm are equipped with purchased Hawker Hunters. There are only two all-weather fighter wings now, equipped with Saab J-32B Lansens. Four of the wings are ground attack units equipped with Lansens in another version.

Remainder of the Air Force includes five reconnaissance squadrons operating S-29C Flying Barrels and some S-32C Lansens, one air base wing and a search and air rescue unit equipped with, among other aircraft, a pair of probably the oldest continually operational Consolidated PBY Catalinas to be found.

Sweden's geographical position is not an enviable one. The country is a little larger in area than California and has about the population of New York City. The frontier facing the possible threat stretches about 1,000 mi. from the 69th Parallel above the Arctic Circle south to the 55th. Defense in depth is just not possible; the country is only about 250 mi. wide at the widest point. Strategic targets are located near the eastern and southeastern coastlines, on the order of 250 mi. from Russian bases in Estonia, Latvia, Lithuania, Karelia and the Kola Peninsula.

The weather can be predictably terrible in winter with violent snow squalls, bone-banging turbulence in the mountains, cloud cover and fogs. Runways

● SWEDEN

have to be continually cleared of snowfall and frequently are covered with glare ice, for which no solution has yet been found. Snow covers the north, and the south can get pleasantly warm. There are more strange phenomena, too; Lulea, a permanent base at the top of the Bothnian Gulf and location of the RSAF's winter test station, is built on sand, and has suffered through a complete sandstorm.

Swedish approach to its problem is classical: build a strong defense and a strong retaliatory force. Keep units mobile so that they can wander to face the threat wherever it is mounted. Staff them with highly competent professional personnel and equip them with the best material that can be bought. Keep them highly trained and constantly alert.

In defensive systems, Swedish radars have been operational for early warning and ground control for about 15 years, with networks being continually strengthened and improved. Underground hangars have been blasted out of the tough granite that makes up much of southern Sweden, and underground shelters have been built for major southern cities.

Active parts of the Swedish system are the fighter and attack units spread along the length of the country from north of the Arctic Circle to the 55th Parallel. All of these units stand a continuous alert, and the closer they are to the threat, the "higher" is the degree of the alert.

Royal Swedish Air Force operates its units and buys its new aircraft on a low budget by almost any standards. Total annual figure for Fiscal 1958-1959 was only about $200 million, and with this money it phased in new equipment and operated a 1,200-plane and 20,000-man air force.

Although Saab Aircraft Co., the only Swedish producer of aircraft for the military, has an outstandingly good production record and is fully aware of and versed in contemporary production techniques, the company's capacity has traditionally lagged the changing needs of the RSAF by about two wings. This is one of the reasons behind the purchase of the Hawker Hunters from Britain, and perhaps one of the reasons for the forthcoming elimination of two day-fighter wings.

The Swedes realize that in the event of war, they will have to fight with what they have on base at the time. There will be no production buildup, and no time for logistic pipelines to fill with spares or new airplanes. For these reasons they want to be as independent as possible from foreign sources, and have gone about logically building up their own industrial capability.

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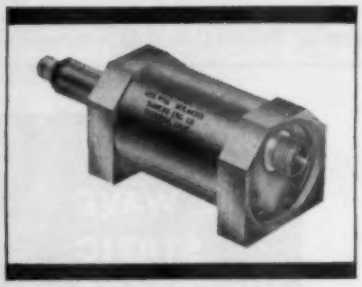

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missiles, conventional armament and the weapons carriers themselves are all now being produced to a greater or lesser extent in Sweden. But in spite of this effort, there is still need to buy some weapons abroad.

Missiles, for example, demand such a magnitude of engineering effort that some observers of the Swedish industrial scene doubt whether or not the country could ever manage a missile program geared to its minimum needs. This has certainly been realized at high levels, and that explains the purchase of the Sidewinders. These inexpensive weapons—cheaper even than the British de Havilland Firestreak and proven in combat—will give the RSAF greatly increased defensive capability and will provide the valuable training and experience needed by both pilots and ground crews as Sweden makes its transition to a mixed force of men and missiles.

In previous years, getting men of the kind that made natural pilots and leaders was somewhat of a problem. The Air Force had to compete with expanding Swedish industry and with Scandinavian Airlines System for young pilots and engineers. The government took a sensible approach to the problem and set up a new short-service program which takes in a young man as a flight cadet, passes him through grades to lieutenant, gives him a college or trade education and, at the end of six years, frees him to take a job in industry besides handing him a fat bonus for having had prior claim on his life.

Last year recruiting was up 40%, a staggering figure. Attributable only in part to some increase in unemployment in Sweden, the figure is regarded by most Air Force personnel experts as an indication of the right approach.

Another figure that looks good is that the accident rate went down by 50% last year, and shows signs so far of staying there or even lower. Safety and survival training starts at the beginning in the RSAF and stays with the men through their careers.

Every man gets a tough survival course and practices it annually by being dumped unceremoniously in the northern snows and told to survive for a while. Every squadron spends some time annually at a far north base.

It's a tough tactical problem that continually faces the Royal Swedish Air Force. Operating over a sector greater than NATO's front from northern Germany to the Mediterranean, RSAF must stay on the alert. In the far north, fighters stand at the ends of runways, pilots strapped in and engines running on fuel from portable tanks nearby. If they get the word to scramble they can start takeoff without any delay.

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Soviets Study Military Aspects of Space

Soviet airpower in 1959 will be based upon expanding programs for both missiles and manned aircraft with a strong research and development effort aimed at achievement of militarily useful space vehicles.

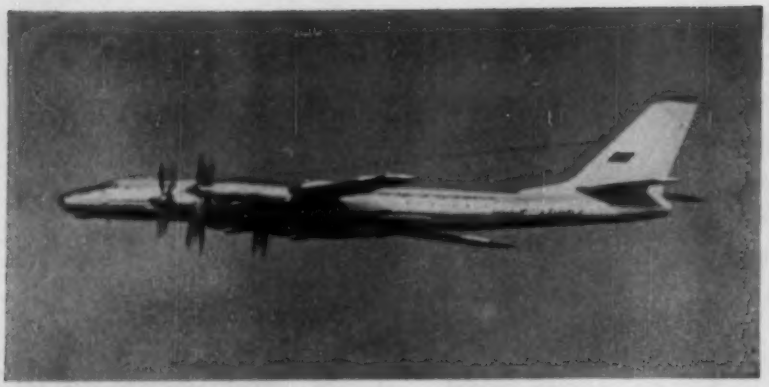
There is considerable evidence that the Soviets are pushing hard along parallel lines in equipping their operational forces in being with both the latest model missiles and manned aircraft for both offensive and defensive purposes. There is no evidence that manned aircraft development or production is being phased out or abandoned in favor of exclusive concentration on missiles.

Most significant increase in the Soviet offensive strength during 1959 will come from its initial operational capability with the intercontinental ballistic missile (ICBM). There is direct technical evidence in addition to Soviet statements that they have completed successful development testing program of their T-3 ICBM over the full length (4,000 mi.) of their instrumented test range from the launching complex at Krasny Yar northwest of the Caspian Sea to the impact areas in northeastern Siberia. This development test program was apparently completed about 11 months ago.

The T-3 has since been put into "series" production in a large industrial complex in the Dniepropetrovsk area, with a rate of 15 ICBMs per month al-

AVIATION WEEK artist's conception of Soviet nuclear-powered bomber shows pods for nuclear powerplants suspended inboard on the delta wing. Conventional turbojets with short takeoff afterburners are on wingtips. The 195-ft. fuselage is to enhance crew radiation protection.

TACTICAL EXERCISES are performed on Soviet Army and Navy Day. Soldiers represent a landing party deep behind an enemy's line of defense. The Mi-4 general purpose helicopter is powered by a 1,700 hp. ASh-82V aircooled radial engine and can carry 14 troops. Soviet helicopter development is now concentrated on the Mi-6 Hook twin-turbine model designed for both military and civil use.



Tu-114D transport is derived from the Russian Bear turboprop bomber.

ready achieved and the possibility of doubling this rate when a duplicate production facility becomes operational. Although the tests of the T-3 have been limited to the length of the instrument range and impact area, Soviet Premier Nikita Khrushchev recently told U.S. Sen. Hubert Humphrey (D.-Minn.) that the Soviet ICBM had a maximum range of 8,700 mi. with a five megaton warhead. Khrushchev indicated that the T-3 had not been test fired over this range because of the lack of a suitably instrumented impact area. However, the propulsion systems used to launch the Sputniks and the Mechta lunar probe clearly indicate the capability of propelling a warhead of about twice the yield of current USAF ICBM warheads over an 8,700 mi. range.

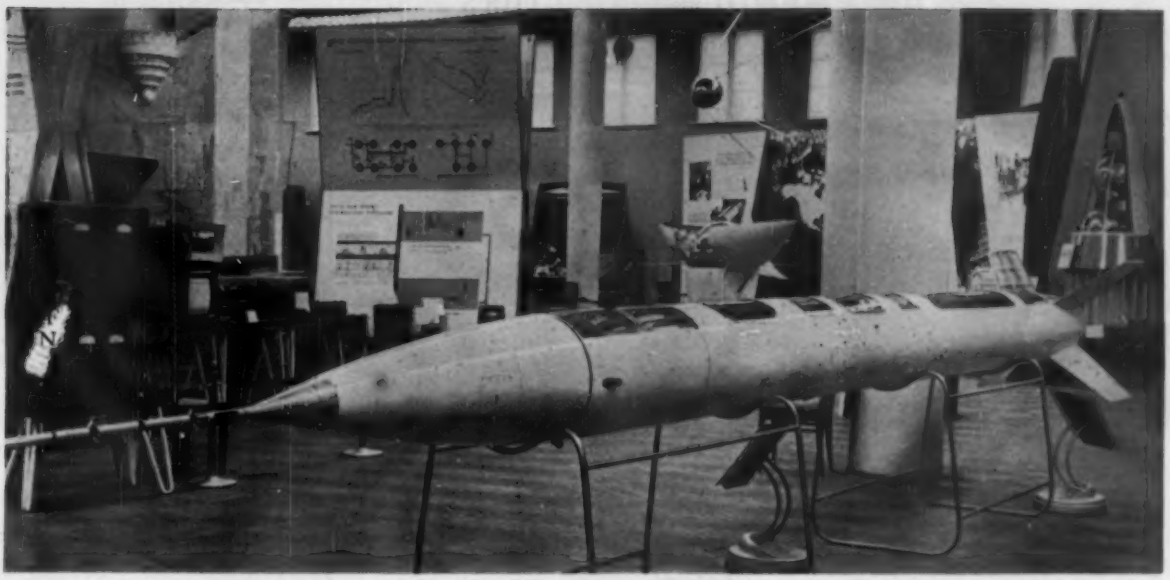
Even the most conservative U.S. intelligence "National Estimates" confirm that the Soviets will have an operational capability of over 100 ICBMs by the end of 1959 or early 1960, with a growth of over 600 by the end of 1962. Coupled with the relatively modest U.S. ICBM production programs now scheduled for both Atlas and Titan, this will add a strategically significant factor in the U.S.-USSR military balance of power during the next 24 months.

While the Soviets are developing an initial ICBM capability, they already have a militarily significant IRBM capability concentrated in western Russia within range (1,000-mi.) of NATO strategic and tactical air and missile bases in Europe and the fringes of North Africa. This IRBM has been in production for several years and has been undergoing troop training firings at rates from 15 to 20 per month on the IRBM test range for over a year.

Soviets are relying on both fixed and mobile launching sites for the IRBM with permanent sites constructed in the mountainous areas of the Balkan satellites, and missile launching and servicing trains spotted on the railroad networks in the area from the Baltic northward. Soviets also have a large family of shorter ranging liquid- and solid-propelled missiles all deployed on mobile launching equipment, ranging from 400-mi. T-1 liquid-fueled V-2 development to the 20-to-50-mi. solid fueled battlefield rockets.

While the Soviet ballistic missile development has been the most spectacular facet of their growing offensive capability, they also have been pushing a wide variety of manned aircraft developments in this field.

Top priority apparently has been given to developing an intercontinental range successor to the relatively short-



RUSSIAN sounding rocket is displayed against background of Sputnik models and its Mechta lunar probe instrument package (center).

legged Bison four-jet bomber. This Bison replacement has been given the NATO code name Bounder and first appeared to non-official, non-Soviet eyes early in 1958 at the famous experimental development and test center at Ramenskoye not far from Moscow.

It has been developed in several prototype versions that may have relatively minor design variations but, in general, it is about 200 ft. long with a delta wing of 78 ft. span and is powered by four engines, of which two are located at the wingtips and two in huge nacelles slung under the wing on short pylons. Initial flight tests of this huge bomber were made on chemically fueled turbojets, and there is some evidence that one prototype crashed in the Norwegian Sea not far off the coast of northern Norway.

Another prototype was recently moved from Ramenskoye to an unknown destination by a series of river

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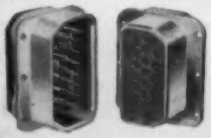

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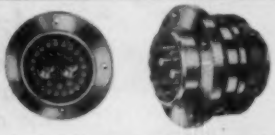

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barges. At least one prototype is equipped with direct air cycle nuclear turbojets in the large pylon-mounted nacelles which have been tested experimentally in the air (AW Dec. 1, p. 27).

Among other design features of the Bounder prototypes are:

• **Large cooling air intakes** along the fuselage near the wing roots which could be mistaken for engine air inlets.

• **Relatively thick airfoil** from the root to the engine nacelle pylon and then tapering to extreme thinness to the outboard engine nacelle.

This wing structure is apparently designed to support extremely heavy weights in the pylon-mounted nacelles.

• **An outrigger wingtip** extending beyond the outboard engine that appears to be jettisonable during or shortly after takeoff. This outrigger could be used either to provide additional wing area on takeoff or to house additional chemical fuel tanks for takeoff performance, or a combination of both. In any case, this equipment would be unlikely for use on an aircraft that would have to make a number of landings and takeoffs but would be relatively economical on a nuclear powered aircraft that could remain airborne for several weeks at a time and make relatively few takeoffs per month.

General concept of the Bounder, although it differs greatly in design, is similar to the USAF WS-125A nuclear powered bomber project that was canceled in the fall of 1957 after several years of preliminary research.

Beyond Bounder, the Soviets are known to be working on a Dyna-Soar-type manned vehicle.

Little is known about the progress of this work except that the basic launching booster yielding close to a million lb. thrust has reached the static test stage. This project has had a high Soviet priority from the end of World War II when the Russians acquired the German research data on hypersonic boost-glide vehicles. There is also evidence that the Soviets are preparing a recovery area for manned orbital vehicles in Central Asia, a necessary preliminary for a flight test program.

While Bounder is in the early development stage, the Soviets have taken several steps to improve the intermediate offensive capabilities of Bison. They include:

• **Equipment for aerial** refueling using the probe and drogue type equipment and the "buddy" concept where bombers are quickly convertible to tankers and no separate tanker fleet is maintained.

• **Equipment for use of** air-to-ground missiles with a 50 mi. range enabling Bison to launch its nuclear bomb load from outside the range of the Army's Nike Hercules defensive missile. Bison

launched missile is solid propelled and in its early stages carried no guidance although later versions probably have infrared or radar homing equipment.

There has been little change in the size of the Bear turboprop bomber fleet during the past year and little likelihood that it will be increased in the future. The Bear is still the only Soviet intercontinental delivery system for nuclear weapons fully operational over intercontinental range. Heavy training activity of both the Bison and Bear operational units has been observed by USAF and NATO radars located on the North Cape looking down into the key airbase complex on the Kola Peninsula and in Alaska and the Aleutians where the Siberian base complexes can be observed electronically.

In the medium and light bomber categories, there has been no significant change during the past year. The twin-jet Badger is still in standard operational service as a medium bomber with no indication that its supersonic successor, the Mach 1.5 Backfin, has been put into production. Backfin has been flying in prototype form for about 18 months. Nor is there any evidence that the Mach 1 Blowlamp, whose initial prototype began flying in the summer of 1956, has been produced in quantity or put into operational service as a successor to the Il-28 as a light bomber.

For offensive operations in the European and Middle Eastern periphery, the Soviet Air Force is depending upon a combination of IRBMs and Badger medium bombers for its striking power, bolstered by large quantities of supersonic fighter-bombers and short range missiles for battlefield operations.

Soviet air defenses are in process of a major qualitative improvement, with the introduction of supersonic all-weather fighters, Mach 2 interceptors, atomic-tipped defensive missiles and improved radar coverage of the Soviet perimeter. Soviet air defense system is based on depth of coverage, beginning with heavy radar coverage and fighter strength in the key border areas and continuing with layers of point defense around prime target areas, with all-weather interceptors in the outer layer and defensive missiles as the inner belt. Soviet radar has been improving steadily during recent years, both in effective range and frequency flexibility and in increased coverage.

First-line operational day interceptor is the MiG-19 Farmer with level flight supersonic performance and now armed with air-to-air missiles using infrared target seekers similar to the Sidewinder. Mach 2 successor to the Farmer is the MiG-21 Faceplate which is now in limited operational service with some Soviet air defense divisions. Also in limited operational service is the Sukhoi-15 Fishpot delta winged fighter. Fishpot

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also is in the Mach 2 speed range and is equipped with limited all-weather capability using short-range airborne radar and is armed with infrared air-to-air missiles.

It is evident that the Soviet combination of missiles and interceptors for air defense systems has reduced the heavy volume production of fighters from the 1950-55 era when close to 15,000 MiG-15s and 6,000 MiG-17s were produced. Neither the MiG-19, MiG-21 or Sukhoi Fishpot appear to be involved in production programs approaching this quantity output.

In the all-weather interceptor field, the Yak-25 Flashlight is still the standard operational machine with its supersonic swept-wing successor, Flashlight C, appearing in some operational service. Both types of Flashlights are armed with retractable belly trays of folding fin unguided rockets, probably containing 24 rockets per tray plus wing-mounted infrared air-to-air missiles. Flashlight radomes are unusually large, indicating a substantial range for airborne target locating and tracking.

Soviet air defense missiles have been emplaced in key areas for at least three years with the initial types publicly displaced in Red Square military demonstrations. These are similar to the Nike-Ajax but have longer range using a solid propellant booster and a high explosive warhead. Soviet atomic tests in Siberia two years ago featured extremely high altitude nuclear detonations indicating development of small warhead packages for defensive missiles. Combination of these Soviet high altitude tests with the results of the U. S. Johnson Island high altitude nuclear bursts a year later, make it more than likely that the Soviets are close to operational use of an atomic-tipped air defense missile similar to Nike-Ajax but aimed at longer range.

Soviets also are pursuing an active development and production program on gas turbine powered military transports with the Antonov An-10 assigned to logistical support of Arctic based Red air force units to replace the Tu-70 which has been the post-war standard long-range transport for this key service backed by Il-12 and Il-14 for short haul work. Antonov also has continued his development line of "bush planes" begun with the An-2 Colt through the Bee and Little Bee designs aimed for operations from even smaller fields than the Colt.

Helicopter development continues with efforts now concentrated on development of the Mi-6 Hook twin-jet model aimed at both military and civil use. Yak-24 twin rotor piston-powered helicopter which has been used in military units for several years will begin civil transport operations in 1959.

MAY 4 OFFICIAL AIR TRANSPORT FACTS AND FIGURES

Once again, AVIATION WEEK has been officially designated

to publish "Air Transport Facts and Figures" as compiled by the Air Transport Association. These official operating statistics will detail the impressive picture of air transport progress witnessed in 1958. In addition, AVIATION WEEK editors will devote extensive editorial coverage to the most significant areas of current air transport development. Included will be a special report on commercial jet operations as experienced by Pan American with the Boeing 707 and Eastern and American airlines with the Electra.

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Space Technology

Pioneer Probe Passes Moon, Orbits Sun

Washington—Army's Pioneer IV lunar probe passed some 37,000 mi. from the moon last week and went into an orbit around the sun that will give it "a lifetime comparable to the life expectancy of our universe," National Aeronautics and Space Administration officials said.

Quick initial study of telemetry returns indicated that the probe discovered no new radiation belts or clouds on its 41 hr. trip to the moon, although tracking was lost for about 12 hr. out of each 24 in its early flight.

Goldstone tracking station near Barstow, Calif., hoped to track the 13.4 lb. probe to a distance from the earth of 400,000 mi., the designed range of the station and the distance at which Pioneer IV was due to be when its 90-hr. lifetime batteries gave out. This distance was to be reached at mid-afternoon on Mar. 6.

Pioneer IV will have an orbital period around the sun of 392 days, reaching its perihelion of 91,744,000 mi. on Mar. 17, the first anniversary of the launching of Vanguard I, and an aphelion next Sept. 29 of 105,829,000 mi. At its closest point to the sun, it will be 1,168,000 mi. inside the earth's mean orbit. At its farthest point, it will be 12,917,000 mi. outside the earth's mean orbit, or between the earth and Mars.

Plane of Orbit

Plane of Pioneer IV's orbit is only one fifth of one degree off the plane of the ecliptic. The probe will reach its ascending node next Sept. 10.

The probe becomes the first U. S. space vehicle to exceed the distance of 71,300 mi. from the earth that USAF's Pioneer I traveled last November. It also becomes the first U. S. asteroid of the sun following Soviet Russia's Mechta, which was launched last Jan. 2. Pioneer IV was fired at the corresponding phase of the moon that Mechta was, so the vehicles have quite similar solar orbits. In both cases, final stage of the launching vehicle is believed to be following the probe itself in its orbit. Mechta's payload was 796.67 lb.

Pioneer IV will pass within an estimated five million miles or so of the earth at the closest approach.

Since Pioneer IV was the last of five lunar probes programed by the U. S. last year for participation in the International Geophysical Year, findings will be made available to all participating nations.

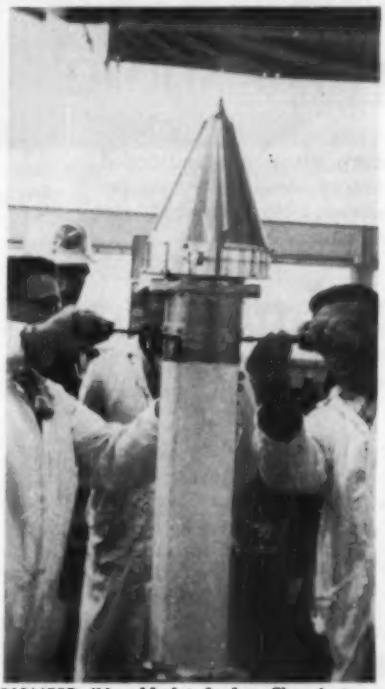
Pioneer IV was launched at 12:10:54 a.m. EST on Mar. 3 from Air Force Missile Test Center's Cape Canaveral, Fla., complex. Three minor errors—in azimuth, injection angle and velocity—caused it to take 41 hr. 14 min. to attain its closest approach to the moon instead of the planned 33½; caused it to pass 37,000 mi. ahead of the moon in the moon's path instead of the hoped-for 15,000 mi., and caused it to pass below the moon's orbit by more than was desired.

Closest approach came at 5:24 p. m. EST on Mar. 4, when the probe was over a point on the earth at 159 deg. east longitude and 22.6 deg. south latitude. The moon was then at 232,000 mi. from earth, but the probe had traveled slightly farther than that because of its slightly curved trajectory.

Probe passed 7.1 deg. east (or ahead) of the moon and 5.7 deg. south (or below). It was then traveling at 4,525 mph. Velocity was expected to drop to a minimum of about 3,400 mph.

It grazed the moon's gravitational field close enough so that its trajectory was affected slightly and its speed "very, very slightly," according to Dr. Homer Joe Stewart, director of NASA's office of planning and evaluation.

Launching was conducted by an Army Ballistic Missile Agency and Jet Propulsion Laboratory team using the ABMA-JPL-developed Juno II vehicle, which is a modified Jupiter with four solid propellant upper stages.



PIONEER IV gold-plated glass fiber instrument package is placed on top of Juno II space probe vehicle at Cape Canaveral, Fla.

Peak velocity, reached at 270 sec. after launch and at an altitude of about 161 mi., was 24,791 mph.—199 mph. over escape velocity at the injection altitude but below the 24,985 mph. desired.

Instrumentation

Pioneer IV contained two Geiger-Mueller tubes, one of which was shielded by four millimeters of lead to study the more energetic particles in the two radiation belts surrounding the earth. Dr. James Van Allen of Iowa State University, who designed the instrumentation, said an early look at the telemetry indicated the instrumentation and transmitter were working well and that nothing unusual had been discovered in the probe's flight.

One of the blackout periods in radio tracking began just an hour before the probe's closest approach to the moon, precluding any chance to detect a possible radiation peak near the moon. Distance from the moon probably precluded this anyway. Probe did not carry a magnetometer.

JPL's 10-ft. tracking antenna at Mayaguez, Puerto Rico, designed to track to a range of 50,000 mi., was able to track the probe to a distance of 104,000 mi. from earth before the probe disappeared below the horizon.

Probe, a conical shape covered with a gold wash for internal temperature control, carried a 108 milliwatt transmitter powered by mercury batteries and broadcasting on 960.05 mc. It provided three telemetry channels. Temperature remained at about 44C.

Instrumentation was included to measure field strengths because a discrepancy was noticed between observed values and calculated values of signal strength on Pioneer III's flight last December, but this instrumentation did not function well.

Probe also included a pistol-shaped optical sensing device that could serve to trigger television-type cameras in later probes. It was to have been triggered by the moon's image if it had passed within 22,000 mi. of the moon, but since its operation depended on image size, it probably was not triggered.

De-spin mechanism consisting of two seven gram weights on wires, wound inside the probe and programed to

swing out at 10 hr. after launch to slow the spin-stabilized probe's rotation on its longitudinal axis, worked at about 11 hr. and 21 min. after launch. Delay was apparently due to inaccuracy of hydraulic timers. Wires and weights were to detach after slowing the spin. Spin was slowed from 324 rpm. to 13 rpm.

Although the probe spent about half of the time on its early flight in radio darkness, there was at least one 15 min. period during which all three tracking stations—Goldstone, Puerto Rico and the 250-ft. University of Manchester radio telescope at Jodrell Banks in England—were tracking simultaneously.

Army May Buy Vertol Three-Ton Helicopter

U.S. Army is negotiating with Vertol Aircraft Corp. for design and development of the YHC-1B two- to three-ton helicopter, the Chinook, which is a tandem-rotor turbine-powered helicopter with a rear loading door. Maximum capacity is 40 troops.

As of last week, detailed specifications had not been released and no production order had been let. Army took the recommendation of an Army-Air Force source selection board in negotiating with Vertol for the helicopter.

Speculation on the engine choice has centered about the Lycoming T55, rated at 1,676 eshp. A drawing of the proposed helicopter showed a two engine configuration with the engines in pods alongside and at the base of the aft rotor pylon. A triple turbine configuration also has been discussed, depending on choice of engine.

Blisters on each side of the fuselage on which the landing gear is mounted are probably for fuel.

Rear loading provisions of the YHC-1B were an important consideration in the Army choice. The squared off tail of the new ship is the most notable difference from its predecessor, the Vertol Model 107.

USAF to Construct Minuteman Facility

Los Angeles—Air Force has authorized construction of limited test facilities at Edwards AFB in connection with its development program for the Minuteman solid propellant ICBM.

Construction at Edwards will include buildings for instrumentation and control, assembly and shop work and will cost approximately $1,770,000. Augmented testing of propellant will be done by using specialized facilities at the Air Force Missile Development Center, Holloman AFB, N. M. Eventually, complete systems flight testing will be done on the Atlantic Missile Range, Patrick AFB, Fla.

Army Corps of Engineers also is asking for bids on construction of a silo launch test complex Phase II, at Edwards AFB. Estimate is that the construction, which will include two silos, will cost approximately $800,000.

While no further elaboration of the function of these facilities is available officially, AVIATION WEEK has learned that silos will be an extension of environmental testing in connection with Minuteman solid-propellant ICBM development, which has been under way at Edwards (AW Jan. 19, p. 68).

Lockheed Organizes New Avionics Division

Los Angeles—Lockheed Aircraft Corp. has set up a separate electronics activity to be known as Lockheed Electronics and Avionics Division. Head of the new division will be Dr. Louis N. Ridenour, formerly assistant general manager and chief scientist of Lockheed's Missiles and Space Division, who also becomes a vice president of the parent corporation.

Electronics Division will have temporary headquarters at Lockheed's branch plant at Maywood, Calif.

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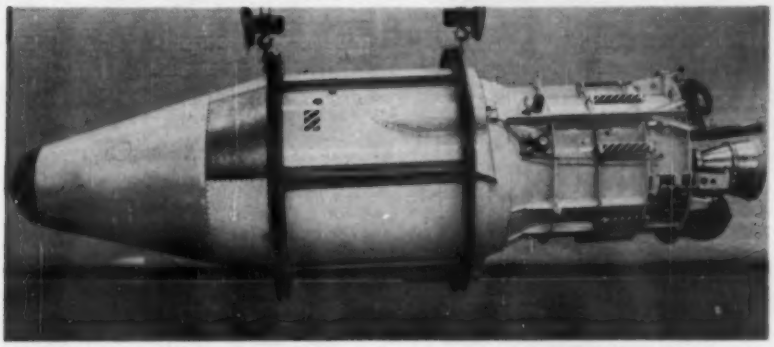
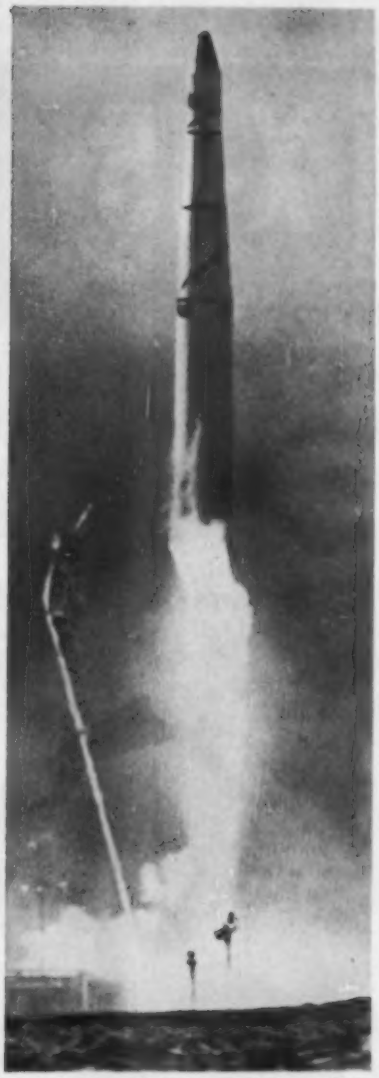
SIXTY-FOOT dish radar antenna at Vandenberg AFB tracking station followed Discoverer.





DISCOVERER second stage including its Bell Hustler rocket motor (left) weighs almost 1,450 lb. after propellant is expended. At right, vehicle using Thor booster lifts off Vandenberg pad.

Space Technology

Orbiting Discoverer Eludes Tracking

By Irving Stone

Vandenberg AFB—Indications are that the United States has ushered in the north-south orbit, with its future all-inclusive reconnaissance potential, with the successful launching here of the first satellite in Project Discoverer. It was also the first satellite to be launched over the new Pacific Missile Range.

No conclusive orbiting data had been acquired last week, but preliminary estimates based on launch phase telemetry indicated that the Discoverer should have gone into its orbital path with a perigee of 146 mi. and an apogee of 558 mi.

Telemetry was lost at 8 min. 56 sec. after launch and when the vehicle was approximately 30 mi. off planned trajectory.

About 22 hr. after launch, signals which approximated the predicted position were picked up on Discoverer's frequency—further confirmation that an orbit had been achieved. But these signals were spotty indicating that the radio transmitters were not functioning properly or that the orbiting vehicle may have been tumbling.

The launch phase showed that:

- **Acceleration** and burning time of Thor booster was "right on the button."
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- **Ignition** of the second stage Bell Hustler engine cut in as planned.
- **Burning time** of the second stage also was in accordance with projections.
- **Doppler velocity** measurement and ground radar tracking all indicated that thrust of the Hustler engine and orientation of the second stage vehicle were perfect to establish the planned orbit.

Tracking facilities both in the United States and overseas were still conducting a search for the vehicle last week. Involved in the search were more than 25 radar stations. Visual and optical tracking installations in the United States and overseas had not been alerted because, due to orbit and time

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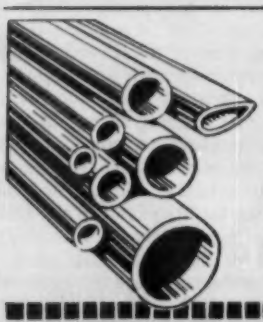

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of launch, the satellite would be in the sun throughout almost all its orbital trajectory. Only exception will be when the satellite is crossing over the polar areas.

Roy Johnson, director of Advanced Research Projects Agency, declared: ". . . While we feel we have conducted an adequate test of the propulsion system, due to the failure of the radio transmitters, we have not conducted an adequate test of the equipment to stabilize the satellite in orbit or of the tracking network . . . following successful test of the satellite stabilization equipment and the tracking network, recovery of a Discoverer satellite will be attempted . . . stabilization and recovery techniques represent new steps in the progressive development of space vehicles . . ."

Immediate objectives of this first Discoverer satellite were to:

- **Prove feasibility** of the Thor-Hustler rocket engine combination to put a relatively heavy satellite into orbit.
- **Check out** guidance system for achieving orbit and basic instrumentation for succeeding Discoverer shots.
- **Test operational aspects** of Pacific Missile Range and Air Force stations which are participating in monitoring Discoverer shots.

Chances of putting the Discoverer satellite into orbit had been considered marginal—only a 25 to 35% probability of success as a result of the weights involved, thrust available, and "first-time" aspects of the Thor-Hustler combination.

Discoverer vehicle represents the first try to evaluate the Hustler engine in any missile flight. Previous tests to prepare it for use in combination with the Thor booster had been confined to static firings of the Hustler at Lockheed's Santa Cruz, Calif., facility.

The complete Discoverer vehicle is a combination of the Douglas Thor powered by North American Aviation Rocketdyne Division's liquid-propellant engine, Bell Aircraft Corp.'s liquid-propellant Hustler rocket engine for the second stage, coupled to a Lockheed-developed instrumented nose cone. Philco Corp. developed the earth-space communications.

The second stage remains integral with the payload-carrying nose cone (AW Feb. 16, p. 30) to constitute the orbiting vehicle, over-all aspects of which were designed and built by Lockheed Missiles and Space Division as principal contractor.

About 20 firings are projected for the over-all Discoverer series, which will establish a large experimental framework of north-south orbitings.

In addition to attempting controlled re-entry and nose cone recovery, the fifth or sixth successful Discoverer shot probably will accommodate biomedical

specimens (mice and/or primates) and be the stepping stone to establish sophisticated techniques contributing to future reconnaissance satellites and manned capsules.

No recovery of the cone capsule was programed for this first firing in the Discoverer series, but various aspects of the recovery technique probably were to be checked out in various degrees to initiate a firm base for actual recovery of a future Discoverer capsule through controlled re-entry procedure.

Prediction is that enough experience should be amassed with two orbiting vehicles to warrant recovery attempt of the capsule from the third vehicle put into orbit. Hawaiian area is now firm as the general recovery site, with Hickam AFB exercising control of the actual recovery. This means that stations in Alaska probably will radio-command the vehicle sufficiently in advance to program the separation of the nose cone capsule from the orbiting vehicle and effect its descent to within 200 mi. of target area.

Already, Air Force's 6593rd Test Squadron, assigned to Hickam and operating Fairchild twin-boom C-119s, is developing techniques for recovery, by use of aircraft, of capsules from orbiting vehicles. Members of the 6593rd have been wearing squadron patches depicting a spread-wing eagle about to clutch an opened parachute supporting an object.

The squadron's present operations, using dummy capsules, are aimed directly at future recovery attempts in connection with Project Discoverer. Recovery attempts probably will see C-119s with nylon ropes trailing from each boom end, joining a considerable distance behind the plane to trail another, long, single cable. At the end of this a relatively large net is carried to intersect the shroud lines and then snag the attached descending chute carrying the satellite's capsule. The procedure will require precise timing and extensive practice to ensure capsule capture.

Was Part of Sentry

Discoverer series was established and broken out of the WS-117L Sentry project in a reorientation of the latter program. Also withdrawn was the infrared or early warning phases, making these and the Discoverer series separate projects under the total WS-117L umbrella.

All of these programs are under direction of Advanced Research Projects Agency, with Air Force's Ballistic Missiles Division as the managing agency. Navy is administering and operating the Pacific Missile Range, over which all Discoverer vehicles will be fired.

In spite of the reoriented over-all program, this first Discoverer shot was originally intended to be the first Sentry firing, which was scheduled for launch in December, 1958 (AW Nov. 24, p. 33).

Main points of the Discoverer vehicle and firing include:

• **Over-all length** of the combined modified Douglas Thor and Lockheed satellite vehicle is 78.2 ft. Satellite vehicle, a magnesium structure, alone is 18.8 ft. long, and 5 ft. in diameter at rocket engine end.

Minor modifications were made to a standard operational Thor to accommodate the second stage. Guidance system, designed to pilot the basic Thor missile to target, was removed along with the nose cone. A few subsystems also were relocated, but otherwise the Thor booster is the same as an operational IRBM. Programed commands in pitch and roll are provided by a tape-fed programer and an autopilot for attitude stabilization.

• **Satellite vehicle** nose cone houses telemetry and communications equipment, which includes a VHF low-power beacon transmitter to simplify the initial acquisition by ground tracking stations and a radar beacon transmitter with a transponder which will allow the satellite to receive commands as well as permit accurate long range tracking. Satellite vehicle mid-section carries fuel and oxidizer tanks. Aft sec-

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tion holds the rocket engine, retrorockets and miscellaneous installations.

• **Total weight** of the Thor second stage combination at launch is estimated at 113,300 lb.

• **Weight** of the satellite vehicle is approximately 7,100 lb., but orbital weight dwindles to about 1,450 lb. after fuel exhaustion but including residual fuel. Satellite vehicle's magnesium structure weighs approximately 425 lb., of which the nose cone tips the beam at about 50 lb.

• **Bell Hustler** rocket engine installation weighs approximately 275 lb.

• **Telemetry equipment** accounts for about 40 lb., guidance about 90 lb., and communications equipment 85 lb.

• **Thor booster** main engine, North American Aviation's Rocketdyne Division development, supplies in excess of 150,000 lb. thrust for liftoff, and burns for approximately 155 sec. Vernier engines continue to burn for about 10 sec. longer.

• **Hustler engine** develops approximately 15,200 lb. thrust to push the satellite vehicle into orbit. Fuel system is helium-pressurized, uses JP-4 and inhibited red fuming nitric acid for the propellant combination, which has a specific impulse estimated to be about 268 lb.-sec.-lb., perhaps about 20 points more than the kerosene and liquid oxygen mixture used in Rocketdyne engine.

• **Discoverer launches** are projected to be only a few degrees off from the north-south path, the vehicle exiting from Strategic Air Command's Vandenberg base at 183 deg., changing slightly as the vehicle is scheduled to orbit.

• **Although a circular orbit** is considered an ideal achievement, the orbital path is expected to have a perigee of 140 mi. and apogee of 450 mi. The plan for a circular orbit contemplated an altitude of 190 mi. if it could be achieved.

• **Retrorockets** are used in separation of Thor from second stage vehicle. Nitrogen jets position the satellite vehicle in a horizontal attitude to earth during the coast phase.

• **Hustler is fired** when position most nearly horizontal is reached, probably about 160 sec. after beginning of coast period. Special mixture of unsymmetrical dimethyl hydrazine and inhibited red fuming nitric acid is used to start the Hustler engine.

• **Gimbaling the Hustler** engine during the orbital boost period, the hydraulic control system, aided by an infrared scanner which looks forward and views the horizon, further orients the satellite into a horizontal attitude. During orbit, high pressure nitrogen is metered to a series of external jets for positioning the satellite.

• **Time for a single orbit** is scheduled to be about 95 min.

• **Orbital life** may stretch out to between 30 and 40 days, but for trials from which nose cone capsule recovery will be attempted, signal for re-entry in the Hawaiian area will probably be given after 19 orbital passes.

• **Beep battery life** potential was "a matter of weeks," one spokesman declared.

• **Elaborate network** of telemetry and receiving and tracking stations for Discoverer is in operation from the Pacific Coast west to Hawaii and north to Alaska. Large radar dish antennas are used, supplemented by tri-helix telemetry receiving antennas.

Tracking Responsibilities

Vandenberg facility acquires the booster satellite combination from the moment it leaves the launch pad. A few seconds later the Vandenberg auxiliary station at Pt. Mugu's Naval Missile Test Center picks up exit telemetry and tracking data on magnetic tape. This auxiliary station also is equipped to transmit command for orbital boost engine ignition at the proper time.

Navy's Pacific Missile Range operates photo-optical tracking equipment at several sites surrounding the launch pad, taking high-accuracy metric pic-

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tures of the vehicle during launch.

Discoverer payload telemetry design encompasses advanced circuitry techniques and miniaturization. Operation is on 15 channels—10 continuous and 5 commuted—which can relay continuously about 100 items of information on performance of vehicle and its systems.

Instrument ship, Navy's USS Joe E. Mann, cargo vessel modified to accommodate telemetry equipment, is positioned about 950 mi. downrange, and records data during the vehicle's coast period, orbital boost and reorientation phases of flight.

During orbit, telemetry and tracking data is gathered by Alaskan stations located on Kodiak and Annette Islands, and by stations at Kaena Point on Oahu in the Hawaiian Islands.

Data from all stations is transmitted to the development control center in Lockheed's Palo Alto Research Laboratory, where orbit profile computations are made using Remington-Rand Univac digital computers.

Orbital predictions and other data are transmitted to the Ballistic Missiles Division in Inglewood, Calif.

Aerojet-General Attains Record Sales in 1958

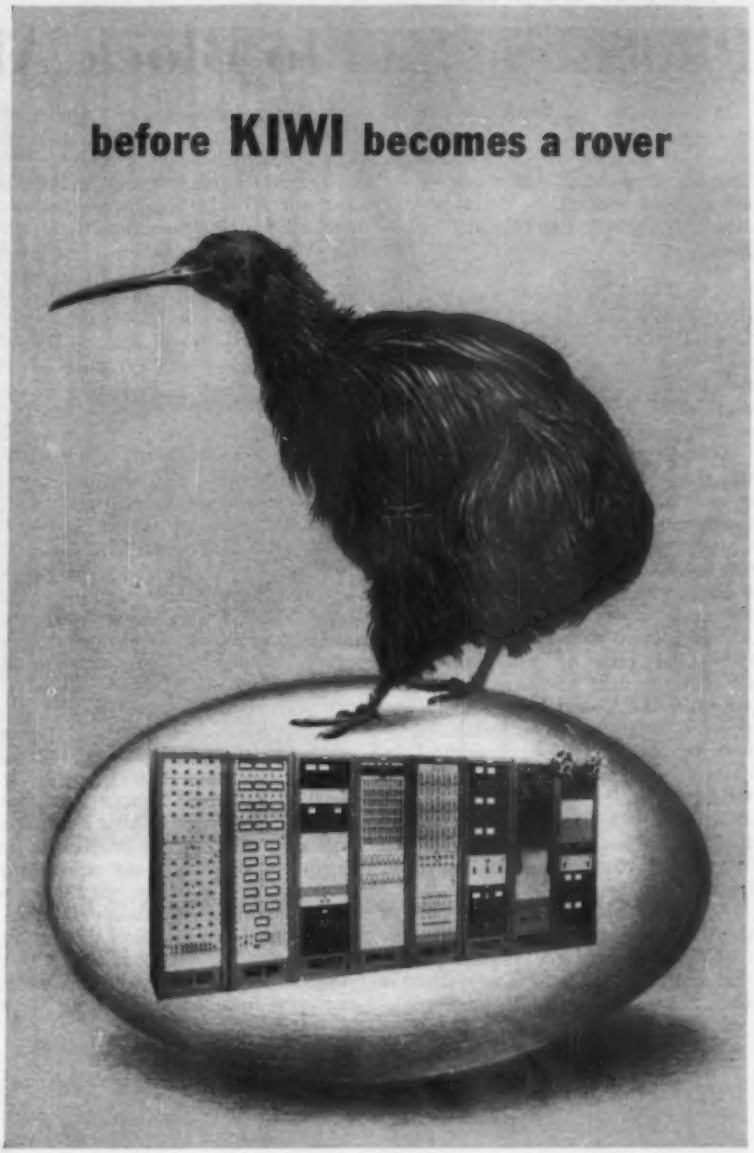
Aerojet-General Corp. attained record total sales of $218,375,000 for the year ending Nov. 30, 1958, compared with $161,877,000 for the previous fiscal year. Profits after taxes in 1958 were $6,028,000; during 1957 they were $3,818,000.

System 609A Details

Washington—USAF's System 609A solid-propellant modular rocket will be stable on three axes and controllable for testing of inertial guidance systems and aerodynamic shapes for advanced vehicles. Selection of contractors is now under way.

The vehicle is the USAF counterpart of National Aeronautics and Space Administration's Project Scout (AW Mar. 2, p. 22) in a joint development program. Both will be inexpensive, multi-purpose test vehicles. USAF system also is known as Project HETS for High Environment Test System.

USAF prime contractor will supply guidance and control, handle systems modification, integration and ground support equipment, and provide test firing. NASA, using a slightly different approach, already has chosen rocket engine contractors and is inviting bids for a contractor who will handle structures and assembly at Langley Research Center, Langley Field, Va., under NASA supervision.



Project Rover is aimed at developing a nuclear-powered rocket engine that will result in man's conquest of intergalactic space. Kiwi-A is its first land-based test reactor, named for the flightless New Zealand bird.

Before Kiwi becomes a space rover, an immense amount of test information will be needed. Edgerton, Germeshausen & Grier, Inc., is cooperating with the AEC, NASA and Los Alamos Scientific Laboratory in collection of this vital data.

For Project Rover, EG&G has designed, built and is now operating an 800-channel control and instrumentation system yielding diagnostic information for designers of tomorrow's spacecraft.

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Pilots File Suit to Block ALPA Payments

Washington—Two airline pilots filed formal suit against Air Line Pilots Assn. president Clarence N. Sayen last week, charging "improper" procedures in assessing $1.1 million in strike benefit payments to Eastern and Capital airline pilots.

Filed by James R. Eads, of Trans World, and Lawrence Shapiro, of United Air Lines, the suit charges that Sayen and ALPA treasurer Don Smith used "improper procedures" in assessing the strike benefit payments during recent walkouts by mechanic and engineering unions at Eastern and Capital.

Attorneys for the complaining pilots said the suit represents the thinking of an estimated 11,000 of ALPA's 17,000 members. The U.S. District Court in Chicago, site of ALPA headquarters, was asked in the suit to:

- **Declare assessments** already levied null and void.
- **Credit sums already paid** by ALPA members to pilots at Eastern and Capital as future dues paid in advance.
- **Enjoin ALPA officials** from taking disciplinary action against members bringing the suit or those supporting its charges.
- **Restore an estimated 40%** of the union membership, who, according to the suit, have refused to pay the strike assessment, to their former status as members in good standing.

Asked to comment upon the charges shortly after they were filed with the District Court, an ALPA spokesman said that there was no basis for the charges since the union's board of directors approved the assessments by a nine-to-one vote. He said he believed the case would be thrown out of court.

In another attack against ALPA management, 13 other charges are now being circulated among the airline chapters by the Air Line Pilots Group. The group, which is composed of ALPA members, charges that the union leaders' insistence on the need for a fourth crew member on jets will lead to reduced pilot pay scales and eventual dissolution of the union. Eads and Shapiro also are leaders of the group.

The District Court suit contends that the action of the union's 300-member board of directors in approving the assessments for Capital and Eastern is unconstitutional under the ALPA charter. In particular, they say the Eastern award is "improper" on grounds that the directors were given incomplete information and too little time in which to cast their votes. It charges that recommendations for payments to the strike-bound pilots, plus methods of assessment and payments, were lumped together and approved by only one vote rather than separate votes.

Eads and Shapiro charge in the suit that, since pilots at Eastern and Capital were not on strike but shut out as a result of strikes by the mechanics and engineers, they were not constitutionally eligible for strike payments but only unemployment compensation.

Basis of the suit revolves about a Nov. 12 agreement between the Eastern pilots' chapter and the company settling the crew complement issue by accepting a fourth crew member. It charges that directors voting the strike benefits for Eastern pilots were not informed of this development at the Dec. 5 balloting and had no knowledge of the settlement until Jan. 9.

Sayen, they said, announced the agreement as "now it can be told" on that date.

Payments to Eastern pilots have ranged from $350 to $650 per individual, the objecting ALPA members said. With $1.1 million already paid out, and only 40% as yet uncollected, the sum total poses a heavy drain on the union's existing strike fund, spokesmen for the Air Line Pilots Group say.

American Airlines pilots, who did go on strike, were unable to collect strike benefits because of a technical interpretation of their company pay periods and time on strike failed to meet ALPA requirements. The American airline pilot chapter is still negotiating this issue with ALPA.

Attorneys for the complainants say ALPA has 20 days in which to file a reply to the suit. As a followup to the legal action, the Air Line Pilots Group opposing the ALPA leadership has told the union's executive council that the suit was filed as the "only recourse" to satisfaction in the hopes that it will unite the many "splinter groups" of pilots into a common cause, "regain ALPA's respect" in the industry and prevent a large segment of the membership from losing the advantage of their good standing.

Dissenting pilot members say that

First Production P6M-2 Flies

First production Martin P6M-2 SeaMaster, powered by four Pratt & Whitney J75 turbojets rated at 15,000 lb. thrust each, has made its initial flight. Predecessor Y6M-1 is powered by four Allison J71 turbojets rated at 10,000 lb. thrust each. The P6M-2's cockpit canopy has been redesigned and increases pilot vision. Wings have greater dihedral because of higher gross weight capability afforded by J75s.

settlement of the crew complement issue at Eastern by placing a third pilot in the cockpit was "ill conceived" since a presidential fact finding board recommended pilot qualifications for a third crew member on jets as a safety measure, while, they charge, the agreement, including use of mechanic-qualified flight engineers in jet crews, seems to contradict the union's stand for a "fail-safe" concept utilizing a pilot-qualified engineer. In a resolution being submitted to all ALPA chapters by the group, the Eastern agreement is referred to as evidence that ALPA reversed itself and established that crew complement is not a prime issue in the contract negotiations.

New Group Hinted

In a lengthy list of recommended resolutions, the ALPG also advised members that ground work has been completed for a new pilots' organization if the "hard core" of ALPA leadership fails to heed the requests of its members.

Referring to its charge of a late disclosure by Sayen of the Eastern agreement, the group called for all elected ALPA officials to provide full information on any subject requiring a vote in order to allow members to judge and direct the actions of union officials.

The dissenting group also is pressing for a ballot by the entire ALPA membership to determine their desire for use of a secret ballot in the election of all union officers.

If adopted, the secret ballot elections would be conducted by "The Honest Ballot Association" of New York, ALPG told the pilots.

Engineers' Charge

Washington—Flight Engineers' International Assn. last week called upon the Federal Aviation Agency for an investigation of the "hazardous effect a fourth crew member may have upon the operation of jet aircraft." At the same time, the union asked Civil Aeronautics Board to stop mail payments to certain airlines because such companies were "using taxpayers' money to pay for a featherbedding demand imposed by the Air Line Pilots Assn."

In a letter to the FAA, the engineers group said that recent airline agreements to carry a fourth crew member aboard jet transports could cause the extra crew member to interfere with the performance of duties on regular crew members. The group told CAB that the "strength" of ALPA "is such that it was able to force an unwanted, unneeded and potentially unsafe fourth crew member into the cockpit where there is not even room enough for him to sit."

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U.K., Canada Reject ICAO Navaid Decision

Montreal—British and Canadian delegations have refused to accept the decision of a special meeting on short distance navigational aids to make DME-T an international standard. The three-week meeting which ended last week was called by the International Civil Aviation Organization to choose between the United States-sponsored VOR/DME-T and the United Kingdom-sponsored Decca navigation systems.

Both the United Kingdom and Canada reserved their position in respect to DME-T, which will enable them to contest the recommendations of the meeting when they are considered by the ICAO council. Before becoming official, the meeting's recommendations must receive a two-thirds vote from the 21-state council.

The meeting was marked by charges and countercharges as the technical and operational merits of the two systems were hotly disputed. After the vote favoring VOR/DME-T (AW Mar. 2, p. 24), the United Kingdom charged, "The expert advice available to the meeting on the need for an area coverage system of high accuracy with pictorial presentation in areas of high traffic density was completely disregarded."

The U. S. and British delegations have accused each other of refusing to compare the two systems on a quantitative basis. The British said, "The United Kingdom has, with regret, been forced to conclude that opposition to the development of quantitative data which would have facilitated an objective examination of the two systems was influenced by the fear that VOR/DME-T would be found wanting when compared with the Decca navigation system."

United States delegates told AVIATION WEEK that efforts to engage the meeting in point-by-point technical comparison of the systems were frustrated by the United Kingdom. As to agreement on operational requirements, a statement by the U. S. delegaion after the vote said, "The record shows that there was a large measure of agreement on the operational requirements. Allegations to the contrary reflect improperly upon the integrity of the meeting as a whole."

Reasons listed by the United Kingdom delegation for not accepting the adoption of DME-T as an ICAO standard are:

• **No objective assessment** has been made of the capability of DME-T to sastisfy the operational requirements, inadequate and incomplete as they are, established at the meeting.

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President's Views On SAC Alert

Washington — President Eisenhower was asked at his press conference last week if he felt that "the present 15 min. ground alert for Strategic Air Command is sufficient or would you prefer, in times such as these, to have an airborne alert?"

"Well, no," the President replied. "I think the alert that is now observed is a good one, and certainly satisfactory for the present moment. The ground—an air alert would be really worse than useless as defense against bombers. You would be much better to have your bombers on the ground.

"Now the day will come when the principal threat, if this situation develops along the lines that it appears to be going, now at that time there will probably be a need for air alert, that is some of your bombers in the air, and they will have to be, of course, refueled more quickly because of the fact that they will have lost much of their fuel during their alert basis.

"But at this moment, I would say the measures taken by the Defense Department are completely appropriate."

• **In the United Kingdom view,** the addition of DME-T to VOR will not solve the problem which arises in areas where traffic conditions and restriction of airspace necessitate a very high order of navigational tracking accuracy and operational flexibility for the efficient exercise of air traffic control and the efficient operation of aircraft.

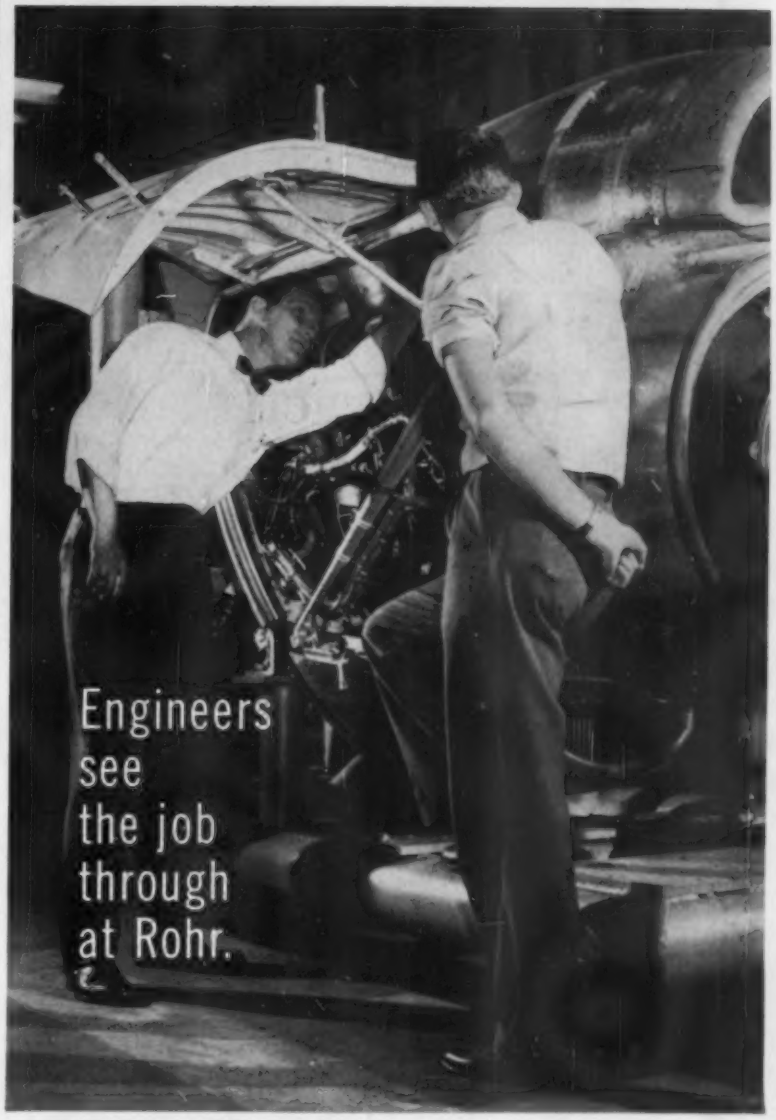
• **An operational** and technical evaluation of DME-T has not been made by a sufficient number of states to justify system's status as a standard.

• **Planning and implementation** of the DME-T system will be difficult and perhaps impossible in some areas owing to the fact that it must be compatible with Tacan, a military system, and must share frequency channels with both Tacan and secondary surveillance radar.

• **Deployment of Tacan** in some areas is subject to military tactical requirements which considerably influence frequency planning and limit the employment of military installations for civil purposes.

The U. S. delegation in rebuttal has prepared and placed in the record of the meeting a list of criticisms of the Decca system which it says forms the foundation for United States opposition to Decca. The delegation's criticisms are:

• **Basic output of Decca** is a group of hyperbolic lines of position, data which is not directly significant to the conduct of the flight or handling of the aircraft. A number of specific functions must be



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executed to provide the significant data from the basically insignificant information.

• **Operational reliability** is more than just the technical functioning of a device each time it is set to working. A much more important consideration is the number of steps required to get, from the basic output, information of significance to the pilot. Each step introduces the possibility of error. The steps required may be automated to a certain extent but each step, manual or automatic, introduces a reduction of operational reliability.

• **Decca has not** been able to show that it can meet all the criteria for a short distance navigation aid: technical reliability, simplicity of use, maximum accuracy consistent with reliability and simplicity and navigation service at altitudes and distances that are operationally significant.

• **Continuing attempts** to achieve operational simplification of Decca have resulted in continuously increased technical complication. Layer upon layer of complexity has been added, and even further improvements contemplated adding still further technical complexity. Decca in operationally usable form is available only to a restricted class of large aircraft, and is highly complex and expensive. The only hope of providing Decca service to other than heavy aircraft is to severely restrict its utility and not exploit its potential advantages.

• **Practical application** of pictorial display to Decca is to prepare flight charts, not on an area basis, but strictly on a route basis. The individual character and distortion of the charts in practical use of the system give the pilot no uniform feeling as to either lateral displacement from the track or distance along the track. The size, complexity, and cost preclude the use of the Decca flight log by many thousands of aircraft, according to the U. S. delegation.

SpaceCommunications Program Detailed

Washington—Top priority has been given to development of a network of military communication satellites in permanent orbit around the earth, Roy W. Johnson, director of Defense Department's Advanced Research Projects Agency, told Congress last week.

Cost of the program, exclusive of rocket boosters and upper stages, is expected to increase from $15 million in Fiscal 1959 to $60 million in Fiscal 1960 and more than $100 million each year thereafter until the program is completed.

Johnson told the House Scientific and Astronautics Committee that the program will be carried out in successive stages leading to a sophisticated global

network which is scheduled for completion in about 10 years. Program breakdown includes:

• **Project Score,** delayed communication repeater. This rudimentary device was placed in orbit in December with a Convair Atlas intercontinental ballistic missile as booster.

• **Project Courier,** also a delayed communication repeater but more refined than Project Score. First firing is scheduled in about one year, with at least two more to follow before the system becomes operational within approximately three years. The Courier, equipped with a magnetic recorder, will receive messages from the ground as it passes over a station and release the message as it passes over the receiving station. The traffic handling capability is equivalent to 20 continuously operating teletype channels each of 100 words per minute.

• **Polar communication project,** a real time communications repeater designed to meet requirements for communication with aircraft in the arctic regions. Knowledge gained from Project Discoverer (see p. 323) will be useful in this project, Johnson said. ARPA plans to make a test firing to put a satellite in orbit within two years and complete all development work in three years. To provide constant communications between ground points in the U. S. and aircraft in the polar regions, several satellites would be required in order that one would be available in the region at all times.

• **24-hr equatorial** orbital satellite, a real time fixed repeater. This satellite will orbit at 19,400 naut. mi. above the earth and remain at a fix spot, providing a relay for points several thousand miles apart. Initial firings to test various subsystems will begin in about 18 months, with the final full test firing of the complete system scheduled to begin in about three years. The first successful complete firing will terminate the research and development phase of the program.

The equatorial orbiting satellite will have a communication capability of 144 voice channels and provide service on an instantaneous basis between points being linked. In addition, it will have equipment for one voice channel for use to aircraft. Minimum requirements for a global network, Johnson said, would be three high orbiting satellites plus four others in a polar orbit at an altitude of 5,000 mi.

• **Long-range program planned** is a refinement of current projects incorporating more sophisticated instrumentation requiring greater weight. Early experiments pointed directly toward this equipment will be carried aboard in some of the later test firings of the Saturn vehicle within the next two or three years. The equipment should be completed in about 10 years.

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New York Airways Plans to Buy Rotodynes

New York—Intent of New York Airways to buy five Fairey Rotodyne 65-passenger rotorcraft was reported by the helicopter airline last week to CAB in certificate renewal hearings here.

Delivery of the first units of New York Airways' $10 million proposed order will begin in 1964. New York Airways' President Robert L. Cummings, Jr., said his company had executed a letter of intent with Fairey concerning the planned purchase. Rolls-Royce Tyne engines are specified.

Glennan Endorses Fuller Information

Washington—Civilian space agency should "report fully and candidly about what we have done and about what we are doing" even though "we're damned if we do and we're damned if we don't" talk about future plans, T. Keith Glennan, National Aeronautics and Space Administrator, said last week.

Glennan said he has "opposed unnecessary and excessive secrecy in the conduct of scientific investigations by governmental agencies for many years," and he finds himself "in complete agreement" with the provision of the congressional law creating the agency that requires disclosure of NASA's work.

Both House and Senate space committees recently had indicated concern over NASA's information policy and had indicated they might make a study to see whether it was meeting the provisions of the space act.

"The American public, the people who will have to pay the costs of our space programs, most certainly are entitled to full disclosure about the way we are accomplishing our vital, assigned missions," Glennan told an Aviation Writers Assn. luncheon here.

"Further, science will flourish best when interchange—free interchange—of information between scientists is encouraged."

Among the facts of life that must be accepted, Glennan said, are:

• **U. S. space program** must be "planned and operated on a sensible and continuing level of effort" because it "is a long-range program, full of uncertainties—one demanding sustained effort and support over a great many years."

• **Although U. S. is proud** of the Vanguard II and Pioneer IV launching, Soviet Russia "today possesses rocket engine systems more powerful than the biggest in our inventory and consequently, for some time to come they will be able to loft into space payloads substantially larger than ours are."

News Digest

Probable successor to Dudley C. Sharp, as Assistant Secretary of the Air Force for Materiel, is Phillip B. Taylor, of Sanderson & Porter, a New York management consultant firm. Sharp's resignation became effective Jan. 31.

Gen. Edwin W. Rawlings, commander of the Air Materiel Command for eight years before his retirement at the end of February, will join General Mills Inc. as financial vice president.

Temco Aircraft Corp. will lay off 2,000 of its 8,250 employes in the first half of 1959 because of dwindling airframe subcontracts.

North American Aviation, Inc., expects 1959 sales again to total a billion dollars. North American's backlog of orders totals approximately $765 million.

Martin Co. sales in 1958 totaled $483,643,681, to make the eighth year in a row of increasing sales volume. Sales for the year ending Dec. 31, 1957, were $423,925,081. Net income for 1958 was $11,725,555, compared with $9,879,638 for the 12 months ending Dec. 31, 1957. Backlog of orders at the end of 1958 was $832 million.

Fairchild Engine & Airplane Corp. is closing its Engine Division plant at Deer Park, N. Y. About 160 of the division's 625 employes will be kept on to finish work on existing contracts and to complete termination procedures for the J83 turbojet engine which was canceled by USAF (AW Jan. 12, p. 32). Fairchild plans to sell the plant.

General Electric Co. has named its aircraft gas turbine organization the Flight Propulsion Division.

Servomechanisms, Inc., Los Angeles, and Laboratory for Electronics, Inc., Boston, are considering a merger on the basis of 2¾ shares of Servomechanisms, Inc., to one share of Laboratory for Electronics, Inc.

Ryan Aeronautical Co.'s net income for Fiscal 1958 was a record $2,287,239. Net income for the year ending Oct. 31, 1957, was $1,804,359. Net sales totaled $73,706,411 for the year ending Oct. 31, 1958, compared with $76,085,016 for the previous year. Backlog of orders totals $129 million.

PICTURE CREDITS:

109, 110, 313 (bottom), 314—Sovfoto; 159, 323 (right)—Wide World; 261 (top)—Russell Melcher; 313 (top)—Aviation Week.

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GENERAL DESCRIPTIONS OF SOME ASSIGNMENTS:

SYSTEMS ENGINEERS to analyze and design computer systems. Backgrounds required include analog to digital conversion; analyses and preparation of diagnostic programs; development of complex devices in servo-mechanisms or radar for advanced systems.

LOGICAL DESIGNERS with two to four years' experience outlining logical blocks. Previous computer experience desirable. Some experience in transistorized equipment specification helpful. Must have strong interest in the theoretical and practical aspects of checking means and various codes, redundancy, error detection and correction, information flow, and other factors.

SOLID STATE ENGINEERS AND SCIENTISTS to do applied research on precision linear circuitry employing solid state devices using analog to digital conversion techniques and sample data. Experience in feed-back amplifier design desirable. Also opening for engineers with experience in precision, low-level linear circuits employing solid state, to work on analog to digital conversion techniques.

T 1 O
2 9
3 8
4 7
5 6
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INDUSTRIAL CONTROL ENGINEERS to perform precision AC and DC electric measurements. Assignments in amplifier design, relay circuit logic, test equipment development, analog to digital conversion, and noise reduction.

CIRCUIT DESIGNERS to design transistor amplifiers, relay lines, transistor tube conversion circuits. Develop systems circuit specifications, perform circuit evaluation experiments and reliability criteria. Other openings in circuit design for magnetic devices.

MATHEMATICIANS to do digital computer programming, handle analysis-of-variance and multiple-regression type problems. Design experiments for wide variation of engineering applications. Knowledge of application of probability or game theory desirable.

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GENERAL ELECTRIC

This is one of a series of professionally informative messages on RCA Moorestown and the Ballistic Missile Early Warning System.

BMEWS AND THE SYSTEMS ENGINEER

Military science, in its need for large-scale, complex automatic equipment, has provided the environment for the evolution of the modern systems engineering concept. To meet the challenge of defense electronics particularly, this comprehensive and logical approach to engineering has steadily grown into a discipline in its own right.

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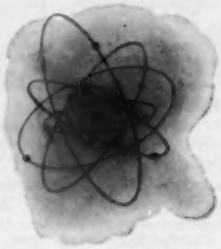

1 Have you worked in electronics for 3 to 5 years?

YES ☐ NO ☐

2 Experienced in telemetering, microwave antennas, servomechanisms, systems engineering, reliability evaluation and analysis?

YES ☐ NO ☐

3 Interested in projects like Subroc, new underwater-to-underwater missile? Or Pinpoint Guidance—designed to steer interplanetary vehicles unerringly through space, advanced aircraft and missiles straight to target?

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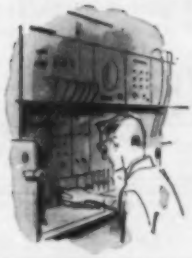
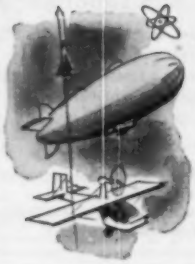


4 Would you prefer a position of specific responsibility, but with plenty of creative elbowroom?

YES ☐ NO ☐



5 How about job security? Would you rather work for an established company with a high degree of diversification—and a proved record of success in many fields?

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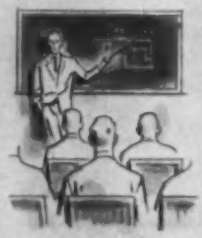

6 Do you feel that you're ready for the big move of your career—the move that will enable you to grow professionally and increase your income at the fastest possible rate over the long haul?

YES ☐ NO ☐

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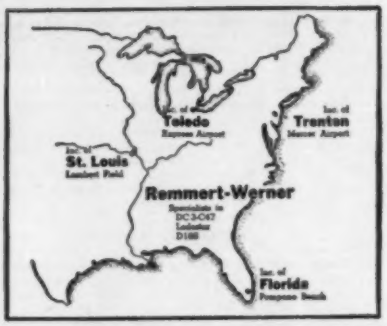

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WILDING PICTURE PRODUCTIONS, INC. 298
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Agency—Brooke, Smith, French & Dorrance, Inc.
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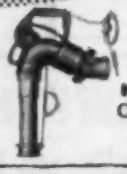
Buckeye's

COMPLETE LINE OF REFUELING EQUIPMENT FOR . . .

OVERWING REFUELING

No. 9162 high capacity nozzle features easy opening, soft closing, minimum shock, during refueling operations. Also No. 8385 Non-Drip oil nozzle for delivering lube oil. Features sure shut-off, non-drip valve in end of tube.



No. 9162 Overwing Nozzle

UNDERWING REFUELING

No. 4092 valve is easily connected to aircraft fueling adapters. Makes a positive, leakproof connection. Basic mechanism designed to deliver 600 g.p.m. at pressure drop of 8 PSI through valve and adapter. Several different models available.

No. 4092 Underwing Nozzle

HYDRANT SYSTEMS

No. 13200 Emergency Shut-off valve can be remotely controlled. Adapter poppet valve and emergency shut-off valve work independently of each other.

Also No. 4096 series standard hydrant adapters; No. 4093 series hydrant coupling valves.

No. 13200 Hydrant Emergency Valve

BUCKEYE IRON & BRASS WORKS
DEPT. A.W., BOX 883, DAYTON 1, OHIO

Please send complete information on Buckeye aviation refueling equipment to:

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*Address*_____

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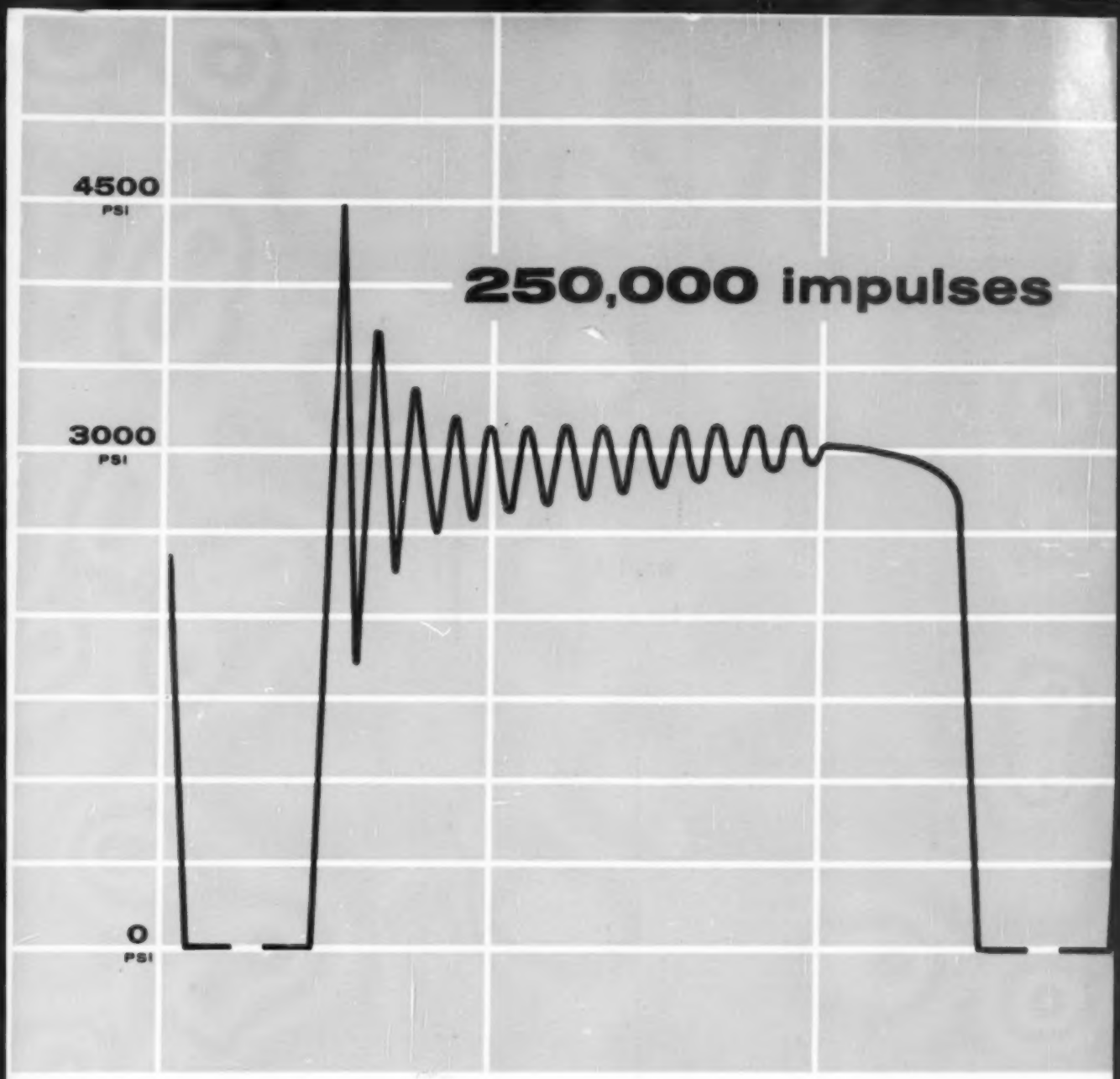


Resistoflex Corporation announces new 250,000-cycle impulse test standards—for 3000 psi Fluoroflex®-T (Teflon®) hose for hydraulic service at 400° F. These Resistoflex standards replace usual industry standards of 100,000 cycles. Reports of completed tests available on request.

Write Dept. 228, RESISTOFLEX Corporation, Roseland, N. J.

® Fluoroflex is a Resistoflex trademark, reg., U. S. pat. off.
® Teflon is DuPont's trademark for TFE fluorocarbon resins

Originators of high temperature fluorocarbon hose assemblies. Resistoflex CORPORATION

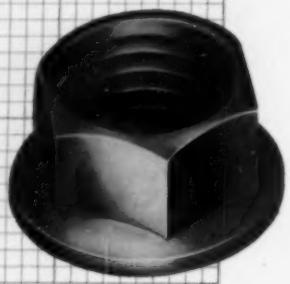
ROSELAND, NEW JERSEY • WESTERN PLANT: BURBANK, CALIF. • SOUTHWESTERN PLANT: DALLAS, TEX.

Again...

ESNA gives the design decision to the engineer

If your major consideration is...

...WEIGHT REDUCTION

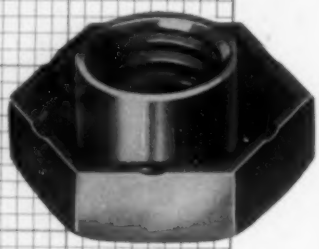


Type LH3324 (160,000 psi)

THIS NEW DESIGN is ESNA's recommendation for applications where space and weight reduction are primary needs. Meets MIL-N-25027; reduced wrenching dimensions permit more center-line efficient bolt design; wrench heights carefully engineered to assure satisfactory assembly line performance. Materials: carbon steel, AMS6304 alloy steel and A286 stainless steel.

wt in lbs per 1000	Screw Size # 4	# 6	# 8	# 10	¼"	5/16"	3/8"	tensile rating
LH3324	.2	.6	1.3	1.4	2.9	5.4	7.3	160,000 psi
NAS679	.9	1.7	2.4	2.6	4.6	6.4	8.6	140,000 psi
AN365	1.4	2.6	4.2	5.0	9.0	12.0	18.0	140,000 psi

...USE OF NAS STANDARD HARDWARE

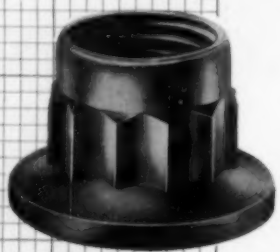


Type LHTE-TM (NAS 679 140,000 psi)

This complete line of low-height, lightweight NAS 679 hex nuts has been designed and produced to ESNA's exacting quality standards. Qualified to MIL-N-25027. External-internal wrenching surfaces for easy installation in limited access areas. Sizes 4-40 through 7/16-20. Alloy steel for temperatures to 550°F; A286 stainless steel for temperatures to 900°F and nonmagnetic applications.

ESNA offers a complete line of ALL NAS types of self-locking nuts, including standard and miniature anchors, floaters and gang channels.

...ULTRA-HIGH TENSILE AND FATIGUE PERFORMANCE



Type LH3393 (220,000 psi)

Specify types LH 3393 and LHEB 220 for the utmost in high tensile and fatigue-life performance. Highest strength-to-weight of any available double hex design. Cold-formed from alloy steels; sizes ¼-28 thru 1". For use at temperatures to 550°F.

Three other lightweight 12 point nut series are available in several tensile capacities and materials for service at temperatures to 1200°F.

Fit the fastener to the application from the only complete line of self-locking fasteners

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. 536-325, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey
Please send me the following free fastening information:

☐ Complete dimensional and performance data of the new type 3324 nut.

☐ Visual Index: A complete pictorial representation of all standard Elastic Stop nuts.

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